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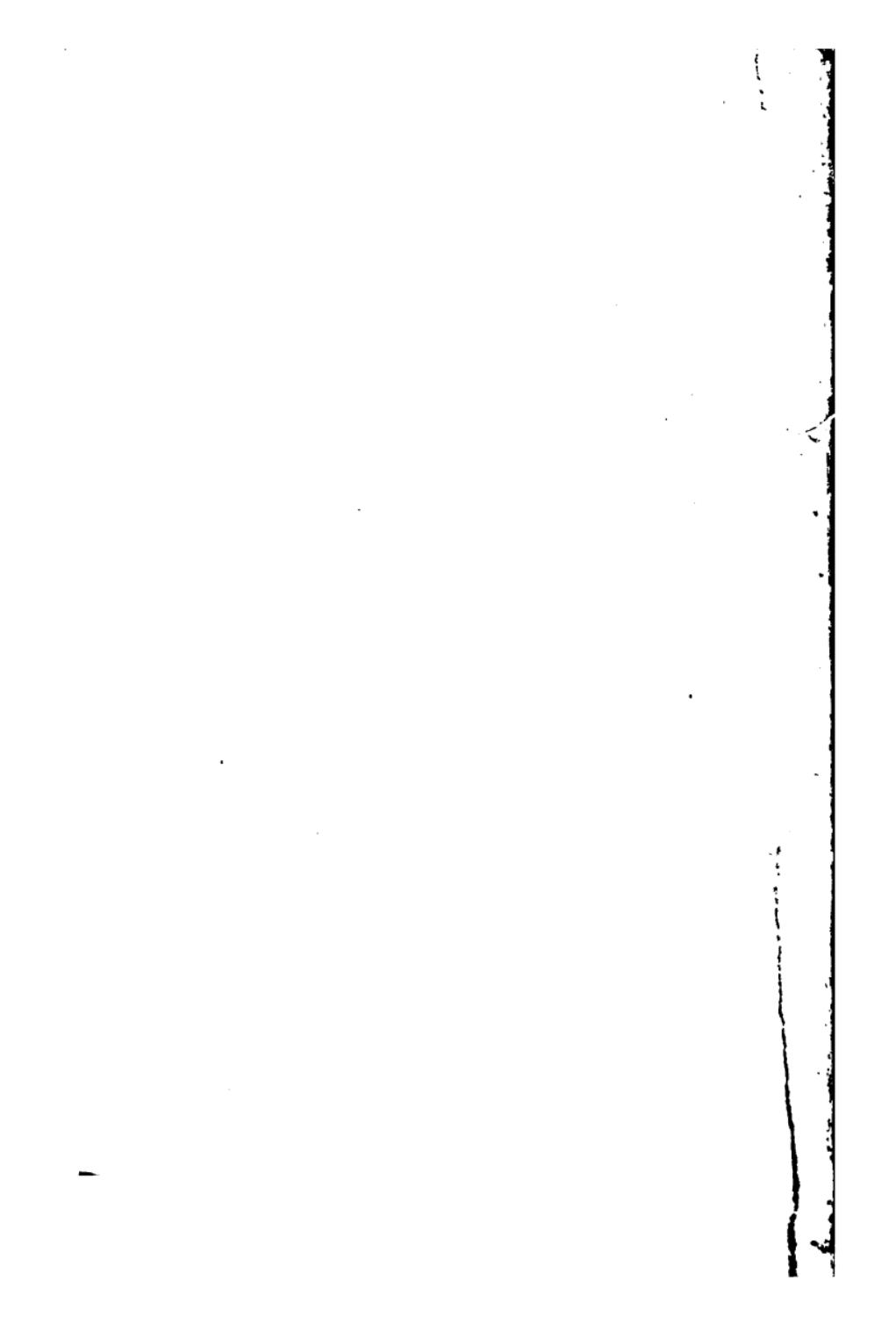
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THE AUTHOR.



Hand Book of Timber Preservation

Souvenir Edition
Revised

*By Samuel M. Rowe, C. E.
M. Am. Soc. C. E. and M. W. S. E.
Mem. A. R. E. & M. of W. Assn.*

CHICAGO
PETTIBONE, SAWTELL & CO., PRINTERS
1904

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ROBERT DELOS ROWE (Deceased).

M. AM. SOC. C. E.

Those labors and intelligent studies and investigations
much that is most valuable in this work is due,
this book is affectionately dedicated.

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PREFACE.

"Since 1885, when the matter was first taken up under the tutelage of the late Joseph P. Card, the author has labored to perfect the methods and appliances, studying each principle and all questions connected with the operation of timber preserving in the direction of convenience, economy and effectiveness. Most of the matter contained is original, and this is the first attempt made to furnish a complete practical guide for the operator, containing full directions, that has been made in this country. Those so far operating works of this kind have relied upon training their own operator and carefully refraining from letting any but general items of information go out.

In a general way, the book is an epitome of the experience and observations of the author, assisted by Robert D. Rowe, recently deceased, giving results of much labor, study and time.

It is not pretended that the operator can take the matter up from the book and proceed at once to run the business, as there is too much that calls for a trained and matured judgment; but the book will be of much service as a handbook and guide during the operation of the plant as well as to hints during the construction.

The author is but too sensible of the imperfect arrangement of the work and that much is yet to do to make it complete, but trusts to be able to offer in the near future an edition that will correct, to some extent, the imperfections of this."

The Souvenir Edition of the Handbook on Timber Preservation issued in 1900 is now exhausted, and to meet the ever increasing demand for information on the practical side of this subject would seem to justify another edition. To meet this demand, the second edition is published after being revised and extended in its scope somewhat.

An effort is made to bring in the writing of other experienced men, as well as to add many items of experience and results of experiments that will aid the student and operator in a fuller understanding of the principles involved in the operation, the nature of the chemicals used, and the character of the woods treated.

The former work has been criticised, some of the statements declared wrong and the conclusions erroneous. That there were mistakes and grounds for criticism is not denied, and where they have been pointed out the critic has the thanks of the author. The author does not claim a high degree of erudition, but has tried to give the facts derived from long practical experience in the business, in a manner to be understood by any man of average intelligence.

In all cases care has been taken to give proper credit where matter has been copied from other authors. Some of the other processes are noticed in a brief way, giving such information as came into reach in the publications of the promoters. Octave Chanute, C. E., John D. Isaacs of the Southern Pacific Railway, President E. P. Ripley and General Manager Mudge, both of the A., T. & S. F. Ry., deserve special mention as furnishing much information that has aided in this compilation.

PRESERVATION OF TIMBER.

INTRODUCTORY.

Section 1. The primary purpose of this treatise is to furnish and collate such information as to the practical workings as shall enable the operator to fully understand the philosophy and principles involved, and to serve as a hand book of information, both during the construction of the works and during the operation of the same.

In the preservation of timber, the machinery to be used, as well as the movements and methods used in the operation of the process, are somewhat complex; just as in the manufacture of steel, in the process of making or refining sugar or of almost any line of mechanical business, so that to insure proper results the operator must not only have a thorough knowledge of the principles involved, but must have a thorough training in the method of handling the plant.

In the first place, the works are expensive, the amount of capital involved in the erection and equipment is a very large amount; then the chemicals are costly, hence any mistake in handling or failure to do good work is an expensive mistake, indeed.

The appliances for the treatment of timber have been brought to such a degree of efficiency that, if properly handled, there is little chance of failure or disappointment in the results.

VARIOUS PROCESSES USED.

Sec. 2. While, as generally conceded, the use of dead oil product of coal tar, usually called creosote, has shown in some cases high results, yet for sev-

eral reasons reference to it will be but incidental, and attention will be given almost exclusively to that of the Burnett and to the Zinc-Tannin or Wellhouse processes, in which the chloride of zinc is the preservative agent. There are two reasons why the creosote process will be largely restricted in its use. In the first place, the process is very expensive, the oil being more and more costly from year to year, and in the second place, there is the difficulty and uncertainty of getting a suitable article. Its much greater cost will necessarily restrict its use to cases where the amount of timber is small and the lasting quality of the timber paramount.

On the other hand, the zinc-tannin process, costing but a fraction of that of the former, has been found only less effective, showing an economy that is very marked, especially when applied to the treatment of railroad cross-ties and bridge timber. It is therefore the purpose to treat here of this matter with reference to this line of work.

As the Wellhouse process is a modification of the Burnett, the latter will be noticed only incidentally, but the former, being the more complex, will be treated of at length.

ZINC-TANNIN OR WELLHOUSE PROCESS. METHODS AND RULES.

Sec. 3. The Zinc-Tannin or Wellhouse process for treating and preserving railroad cross-ties, bridge or other timbers against early decay, consists in first subjecting the timber to the action of steam in an air-tight, sealed retort for such length of time as is found necessary to open the pores of the timber and loosen and expel the natural saps. This is followed by a vacuum of from 18 to 26 inches, thereby withdrawing all the vapors and freeing the timber from condensations of steam introduced and of the volatilized saps.

Sec. 4. This is followed by the introduction of zinc-chloride in solution one and a half to three per

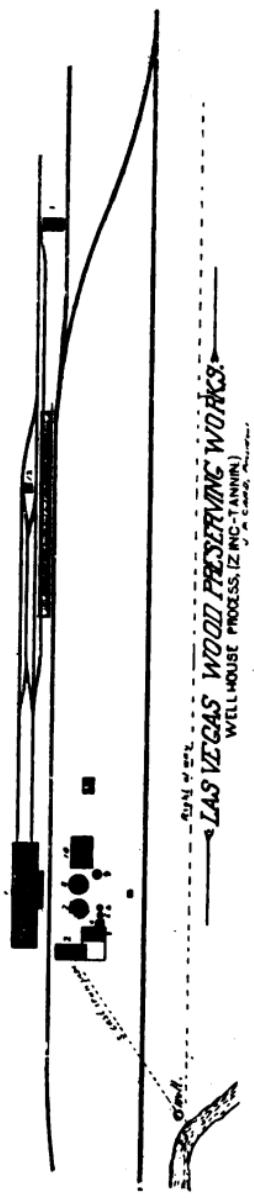


FIG. 1—ORIGINAL YARD (LAS VEGAS).

cent strong, as the character of the timber under treatment shall require, the solution carrying at the same time one-half of one per cent in weight of dissolved glue.

This solution is held under pressure of 100 pounds for a period of two and one-half hours to six hours, depending, as before, on the character and condition of the timber treated.

Sec. 5. The retort is then freed by forcing the chloride solution back into its receptacle and introducing a one-half of one per cent solution of tannin and holding it under pressure, as with the zinc and glue, for two hours or thereabout and then withdrawing it, completing the operation. This process is sometimes varied by introducing the glue in a separate solution, in which case a separate tub will be necessary for the glue solution.

Sec. 6. This process under consideration differs from the Burnett only in the addition of the glue followed by the tannin, the glue and the tannin combining and forming a leathery and insoluble product which helps to render the timber impervious to the absorption and giving off of water, so protecting the chloride, which is supposed to be easily washed out of the timber, thus losing its antiseptic effect.

Sec. 7. The wide range in time is necessary to meet the difference in the character and condition of the timber, and the proper and most economical and effective practice can only be fixed by first determining what absorption can be secured, and thenceforward conforming to this. This can best be done by varying the time or the strength of the solution, or both.

Sec. 8. A very important requirement is that the timber being treated shall have a reasonable amount of seasoning, say sixty to ninety days, varying in length of time as climatic conditions shall vary.

In a warm, dry climate, sixty days may be ample, while in a moist, cold climate much more time will be necessary to fit the timber for good results.

Sec. 9. That a sufficient amount of antiseptic be introduced, and its thorough dissemination through the piece, is the essential point to be attained.

It is only by careful observation and study by an experienced management that the best results can be secured.

CAUTION.

Sec. 10. The process and methods here outlined have been in practice many years with results that place them beyond the sphere of experiment, hence any departure from them with a view to improve should be guarded against and deprecated by the management. Any experiments in the direction of improvement should be made by those competent to direct and situated to carry out a long series of experiments. Even this should be attempted with caution and hesitation, as it takes long to get definite results.

APPLIANCES.

Sec. 11. The appliances used are much the same as those for the Burnett or creosote processes, the minor appliances for preparing the chemicals only differing. In each and all the steaming is identical, and the storing tanks and piping are interchangeable from one process to the other.

First—The steam plant for furnishing the necessary steam to the retort, for driving the different pumps and machinery, including a dynamo to furnish light, and to steam coils for heating the works.

The electric light is quite essential, as the works should run night and day.

Second—The retort, sometimes called the cylinder, made of steel plate, and of such dimensions as will receive the charge with its tram cars on which the timber is loaded in such shape as to fill the cylinder as nearly as possible. The retort most convenient is usually about 106 feet in clear length, capable of receiving thirteen tram cars with their

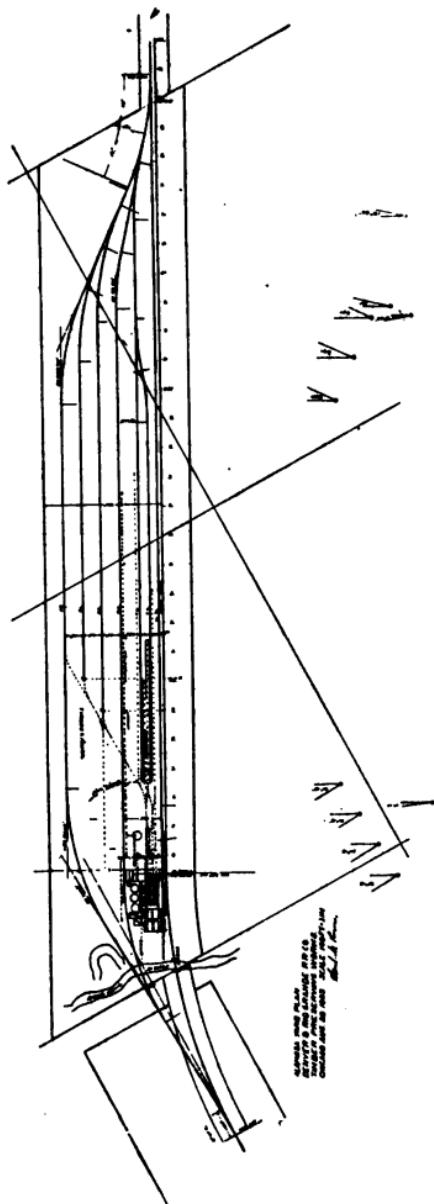


FIG. 2—ALAMOSA YARD

loads of eight-feet ties, and of such diameter as is deemed most suitable and convenient, generally about six feet. It contains tracks on which the tram cars run, the gauge of which is the same as that of the tram-yard tracks, by means of which the charge is run in and out.

The retort is provided with a strong door, self-sealing, or may be hand-bolted as may be desired, fitting tightly to resist pressure and to prevent leakage and waste.

THE "SPIDER" DOOR.

The retort door, as shown in Fig. 4, is old as to its general form, but has lately been improved in its details so that it proves economical even at an increased cost. The door with its hinge arms is cast in one piece, from cast steel with a large reduction of thickness over that of a cast iron door. It is faced in the lathe and fitted with stud screw 4 inches in diameter; the hub is fitted with a bronze bushing working closely on the buttressed thread of the screw, and the friction plates, made of the finest tool steel, have two circles of steel balls, which almost entirely eliminates friction, enabling it to close quickly and with the least amount of labor.

Ordinarily only one door is necessary, aside from avoiding the expense of a second door, complications in the appliances and the operation of charging the retort, no special advantage is derived from such an arrangement, as the confining of operation to the one point is believed to be the most economical.

The weight of the cast steel spider door is about 6,500 lbs.

WEIGHT OF CASTING FOR CAST STEEL DOOR, FOR RETORT.

Dia. $78\frac{1}{2}''$ - $2\frac{1}{2}''$ thick. 14,486 cu. in.
Extra at hub, 810 cu. in.

-15,296 cu. in.

1,728"

FIG. 8—STEAM BOILERS.

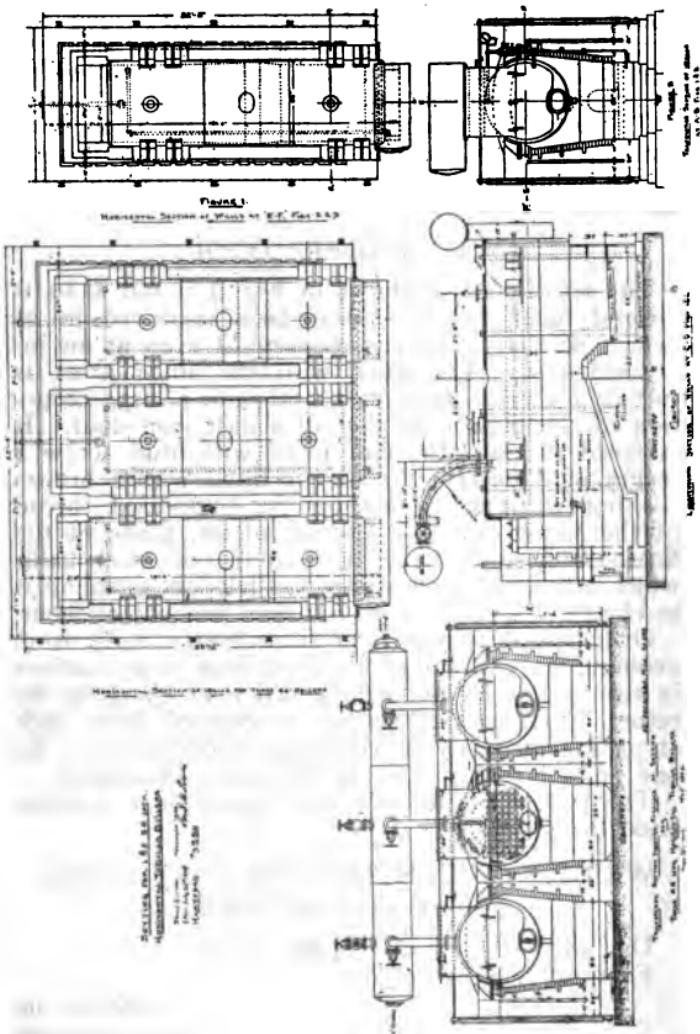
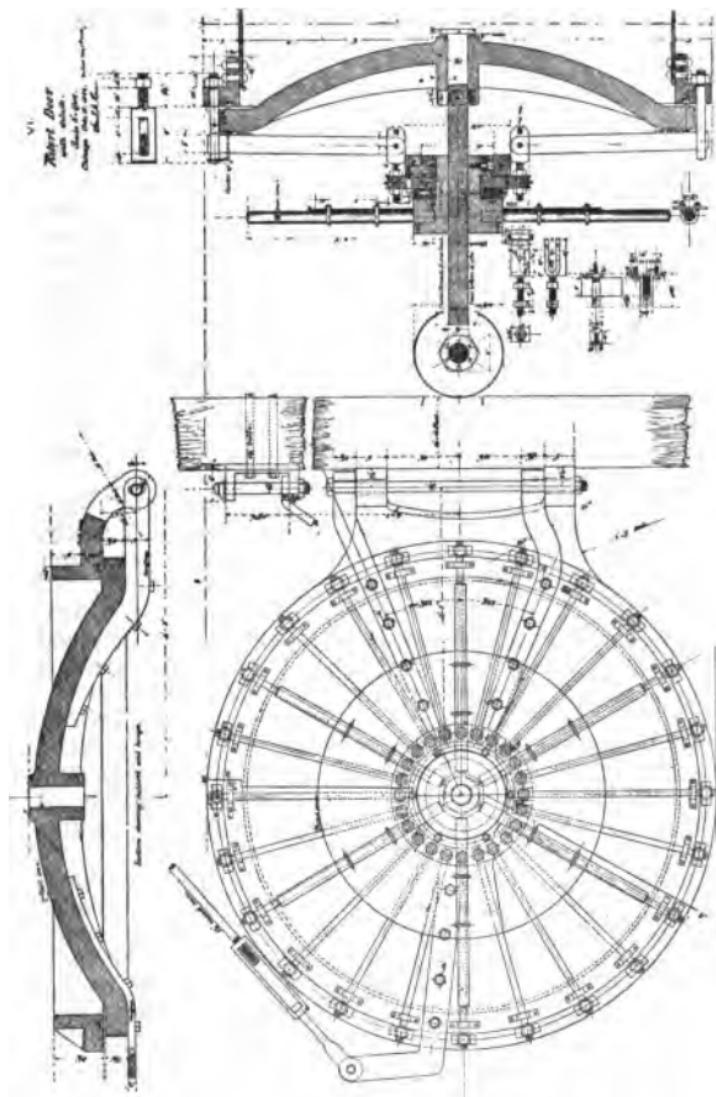


FIG. 4—SPIDER DOOR.



equal 8.852 cu. ft. \times 400 lbs. equal 4,337.5 lbs. cast steel—say 4,400 lbs. exclusive of hub and fixtures.—Hingearms 200

4,600

For hub, add 700 lbs.

Other fittings, 500 lbs., and stud screw, 750 lbs., making a total of 6,300 lbs.—say, 6,500 lbs.

Third—The vacuum pump, used to free the retort from air and vapors remaining after the steam has been released from it, to encourage the outflow of natural saps of the timber and to prepare it for the ready absorption of the solution by freeing it from hot vapors and expanding the small amount of vapors remaining. In connection with the vacuum pump, and a very important adjunct, is the surface condenser and the hot-well, by which the vapors are condensed before reaching the vacuum pump, relieving it of a large part of its labors.

Fourth—The air compressor, by which the solution used is forced back into its receptacle quickly, by pumping air into the retort, as well as for other purposes where compressed air is desired.

Fifth—The force pump, by which pressure is produced upon the charge in the retort, a boiler-feed pump, a pump for handling water for the various purposes about the plant and for fire security.

Sixth—Large tanks or receptacles for the various solutions, consisting of a tank for the prepared chloride solution, a tank for the tannin solution and a tank for water storage, each of which should be of such dimensions as will amply meet the requirements of the plant.

Standard railway tanks will do for a small plant, say for two retorts, but for a larger plant a tank 30 feet in diameter and 20 feet deep, holding something like 100,000 gallons, is about what is most suitable. These may be of wood, iron bound except for creosote, which should be steel throughout.

Seventh—The vats for the preparation of the chloride should be of wood, lead lined, the one for

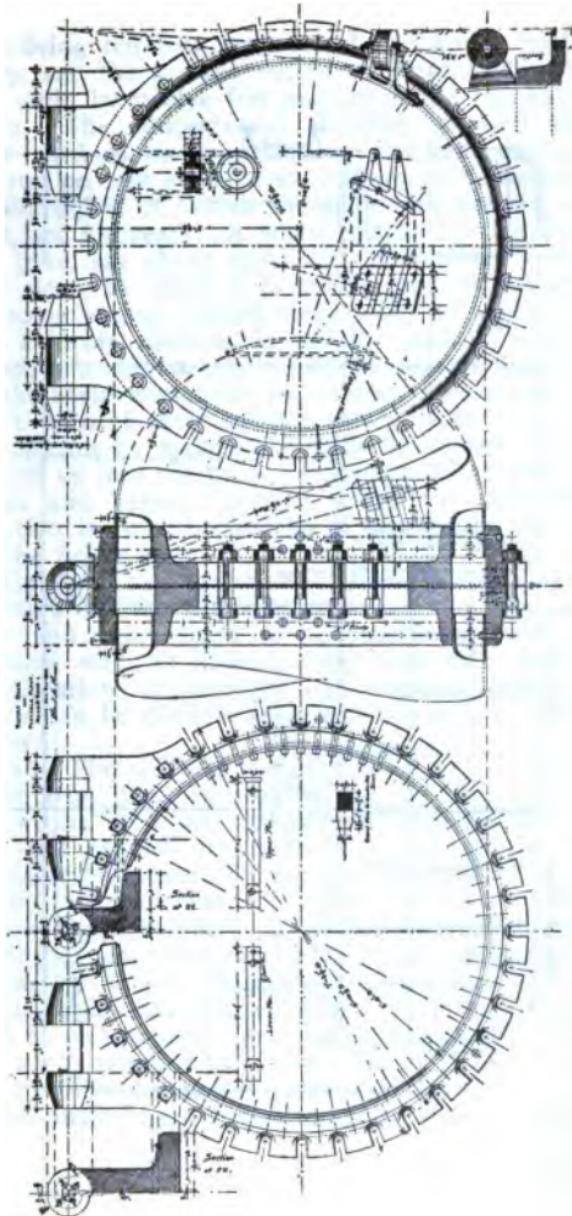
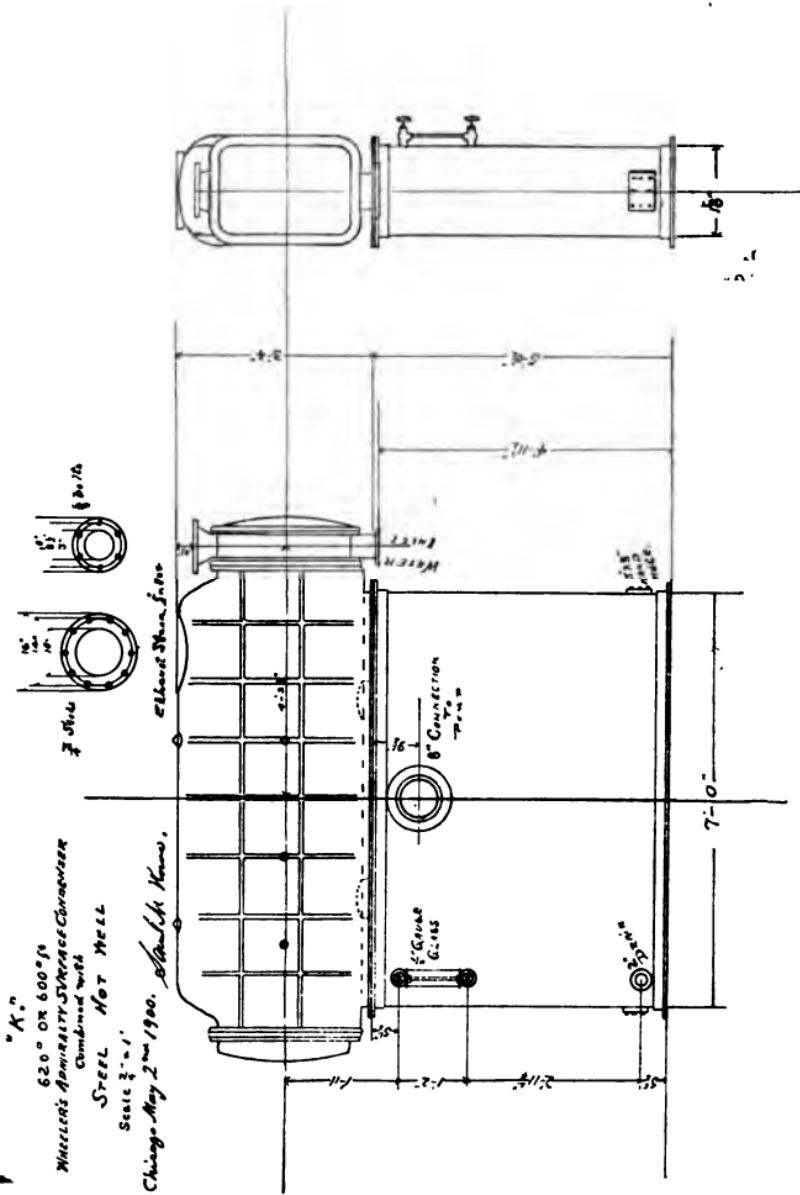


FIG. 6—BOLTED DOOR



dissolving ten feet square and two and a half feet deep, and the storage vat for concentrated solution, say eight by twelve feet and three and one-half feet deep. The concentrated chloride, as well as the acid used in its manufacture, are both destructive to iron or even steel, hence a lining of half-inch lead is interposed on which the acids will not act, hence will last for years. A small mixing tub for dissolving glue, say about eight feet in diameter and four feet deep, in which it is soaked and dissolved, and to some extent diluted preparatory to mixing with the chloride solution, is usually used. The tannin requires a similar tub, in which four or five barrels of the bark extract can be emptied, diluted and used.

To each of these mixing vats or tubs is provided an ejector, by means of which the contents can be forced up into the proper receptacle as needed. The pipes and valves, through which the concentrated solution is passed, must be of chemically pure lead, as the lining is.

Eighth—The system of iron piping to carry through all the different movements is too extensive and complicated to be described, except in a general way, as almost every case calls for some modification on account of special conditions. They can be divided and described in the following order:

(a) The solution pipes consist of a system of large iron pipes connecting the solution tubs with the retort by which the movement is quickly made, the full control of which is in the hands of the operator by means of a system of valves.

(b) The air and vacuum pipes are a system of piping through which connection between the retort and the vacuum pump and the air compressor is made, by which vacuum is drawn and by which air is forced into the retort in forcing back the solution to its receptacle, and also by which the steam or the air is released from the retort.

(c) The circulating system is a system of minor pipes, including a force pump by which a plentiful

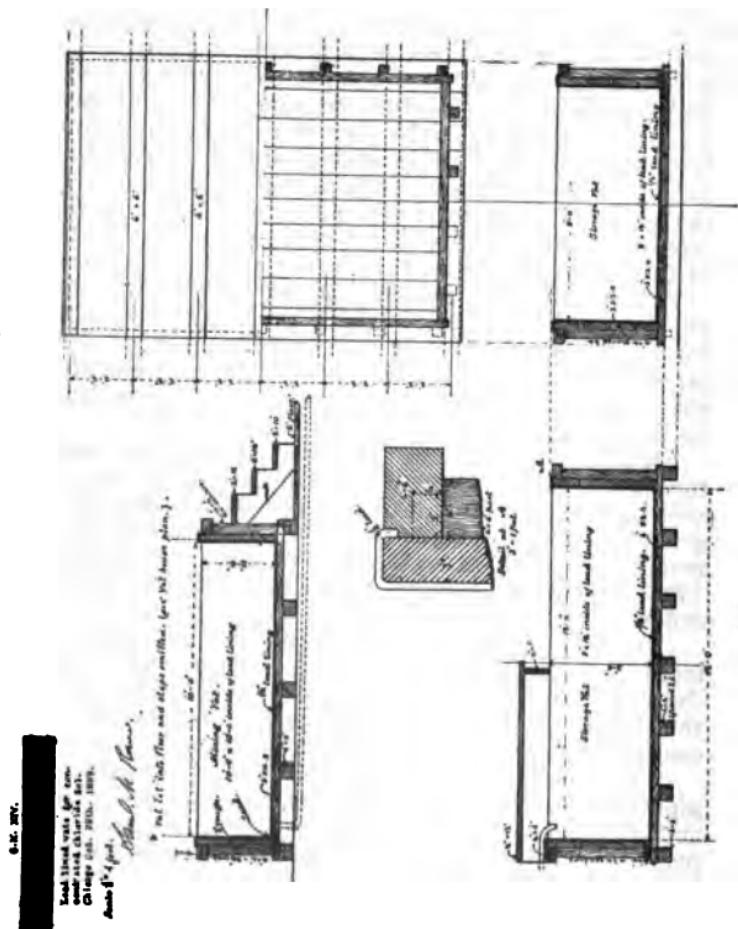


FIG. 7—LEAD LINED VATS.

C.N.XVII

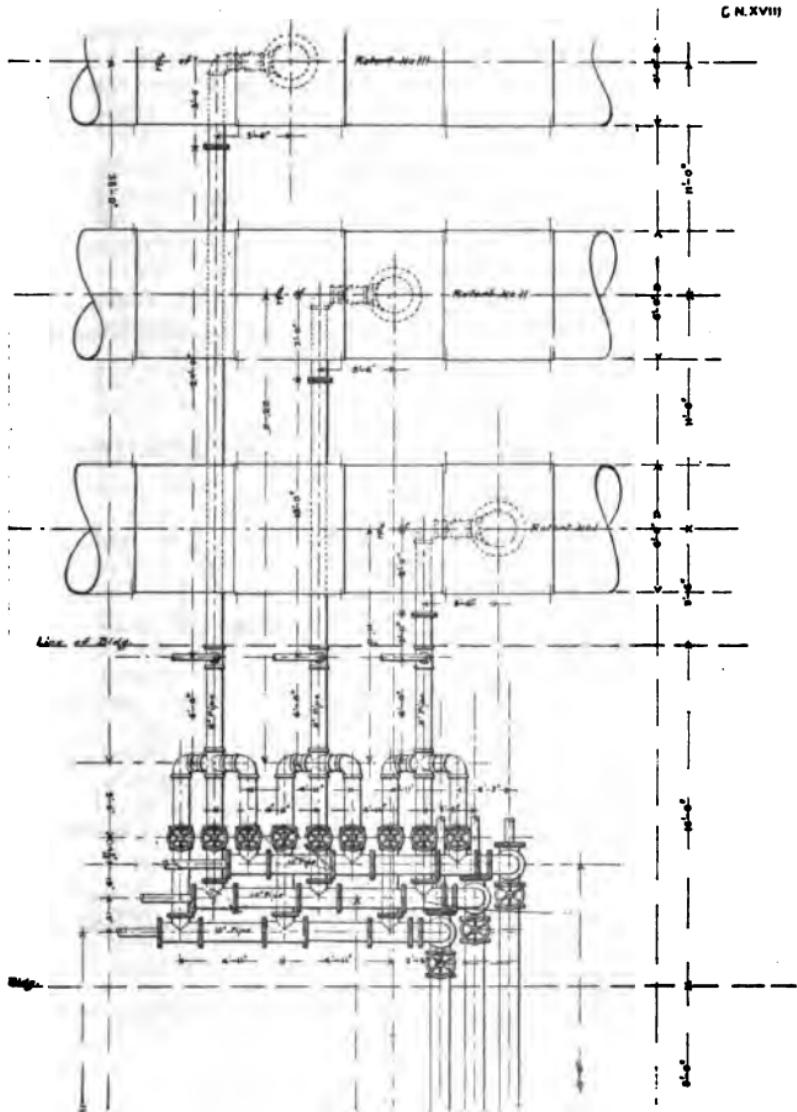
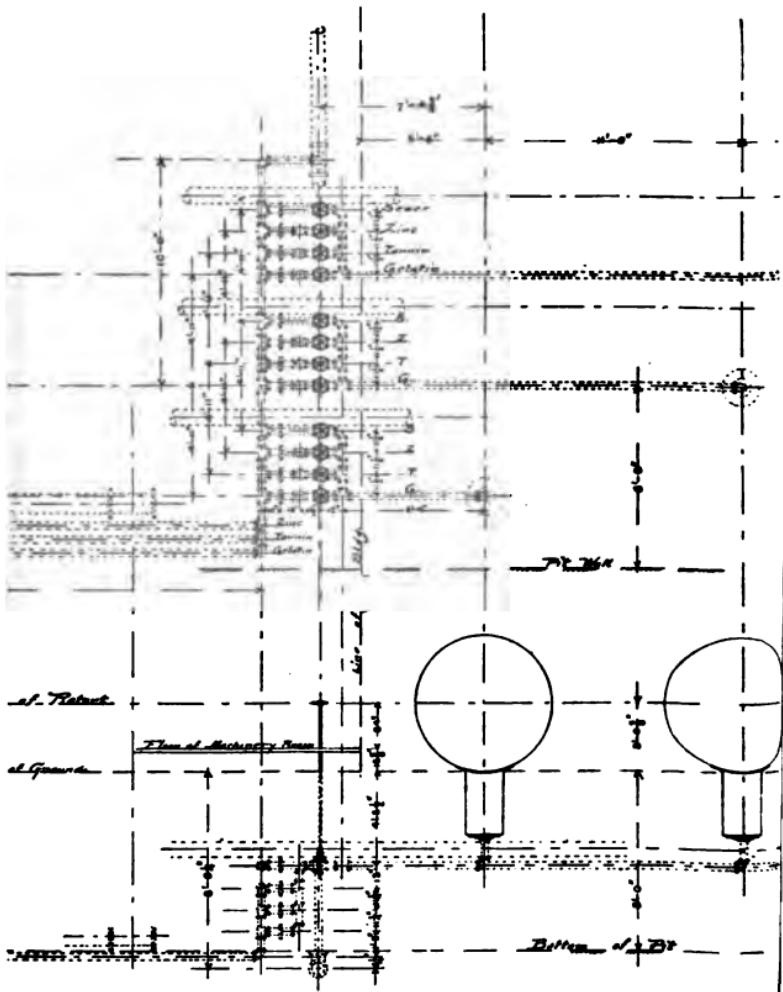


FIG. 8—SOLUTION PIPES (3 MOVEMENT)



stream of cold water is forced through the surface condenser during production of vacuum, by means of which the steam and vapors from the retort are condensed and cooled before reaching the vacuum pump.

(d) The blow-back system is a set of pipes of minor size by which the last remnant of solution is forced back into its proper receptacle by means of the air compressor continuing its service after the solution valves are closed.

(e) The puddler consists of a system of small pipes connecting between the compressor and the solution tubs, the chloride dissolving vat, the chloride storage vat and the glue and tannin mixing tubs, by which they may be agitated by a stream of air from the compressor.

This is quite important, as it keeps the chemicals in the solution in suspension and aids in rapidly dissolving those in the mixing or dissolving vats.

(f) Steam coils and heating pipes. These consist of steam coils in each of the solution tubs by which the desired temperature is secured to each solution; also such radiators as may be necessary to heat the building, all having steam direct from the steam boilers and discharging all condensations by means of a steam trap to the boiler-feed tank or to any desired hot-water reservoir.

(g) Steam pipes. The steam pipes from the boilers by which steam is furnished to each of the pumps, engines, etc., need not be further noticed here except to say that they should be of ample size and should lead as direct as possible to each machine, and should be well protected against radiation. This should be especially and effectually done with the line conveying steam to the stationary power by which charges are handled, which are located at considerable distance from the boilers.

(h) Suction and discharge pipes of the various pumps need here only be mentioned.

(i) Service and security against fire.

In large plants, a large force pump connecting

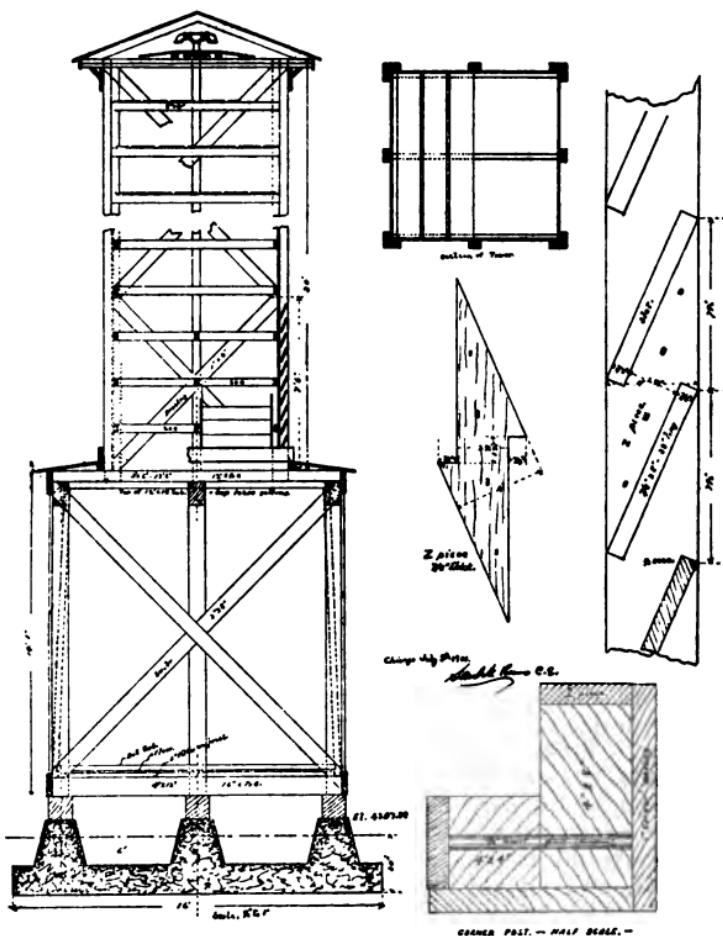


FIG. 9½.

In a case where water is scarce and expensive a cooling tower is used (Fig. 9½) in connection with the circulating system by which the cooling water after passing through the condenser is forced to the top of the tower and then released and allowed to drip back into the tank from which it is drawn. Thus it can be used over and over, little being lost.

with an ample supply of water in case of fire breaking out, the discharge of which, with its pipes, to the various parts of the works, and sufficient number of hydrants and ample supply of hose, is a very important adjunct. It may be made to do general pumping service, at the same time being always ready for a fire.

(j) Automatic drain from the retort. This is an arrangement of pipes connecting the drain well of the retort to the sewer by which all condensations during the operation of steaming shall be carried to the sewer, thereby keeping the retort as free as possible from water.

It may be arranged to operate automatically by means of a steam trap, or it may be operated by the operator by means of a valve in case the steam trap fails to operate.

All of these systems must be planned and plainly delineated to work together harmoniously, nowhere interfering with each other, and each constructed so as to do its work properly, and the outlines and dimensions put on paper so that the shop men can make every piece and put it in its place.

Ninth—The power required for charging and discharging the retort, and for moving the tram cars in the yard is furnished by a stationary engine. By means of a drum and cables supplemented by fixed snatch pulleys in different positions, the operation can be carried several hundred feet each way. Two and sometimes more of these shifting engines are required in a large plant.

Tenth—Tram-yard tracks. This consists of a system of tram tracks conforming in gauge to the tracks in the retort and extending with switches, cross-overs, etc., such as the dimensions of the works shall require, by which timber is brought from a standard railroad yard or from storage piles and conveyed to and from the retort, and again discharged into piles or loaded on cars for reshipment. While the gauge of these tracks must be the same as that in the retort, yet heavier rails may be used, and 48 to 56 old rails can be utilized.

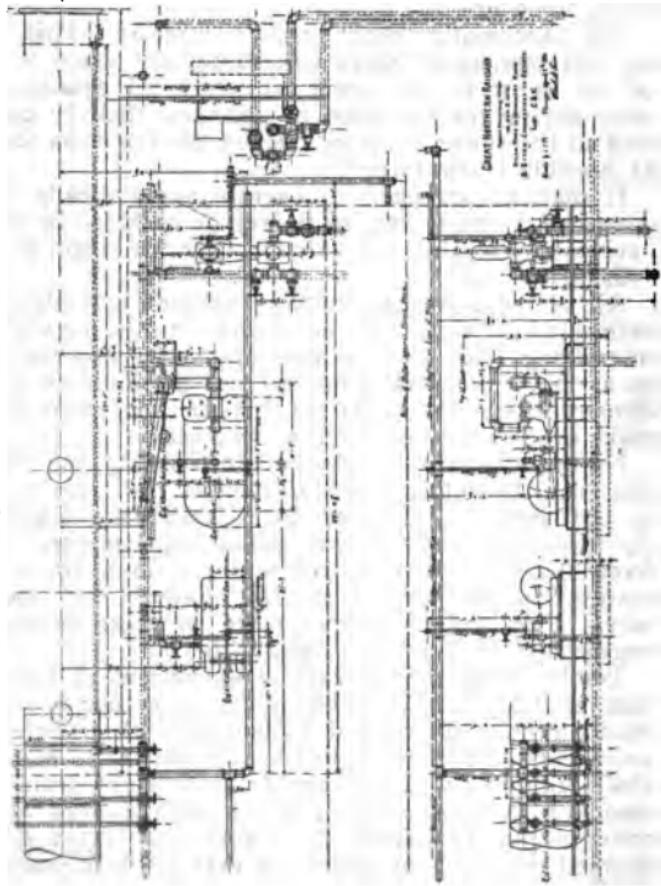
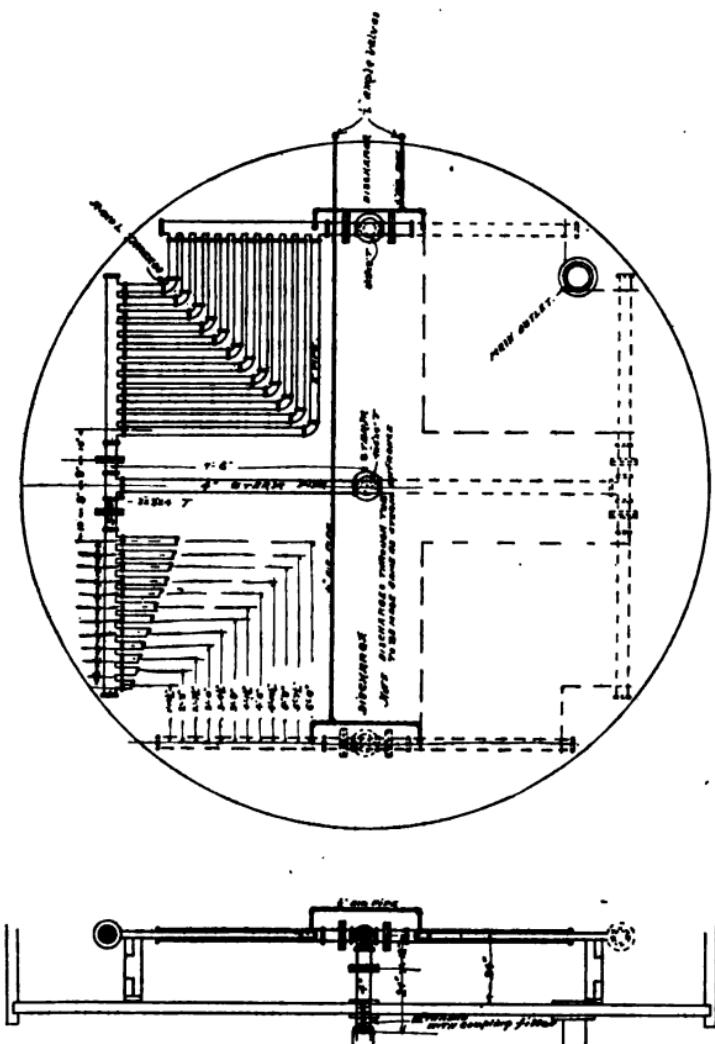


FIG. 10.—STEAM PIPING (G. N. R.Y.).



HEATING COIL FOR CREOSOTE TANK
DIA. 5' 7"

Chicago, Nov. 15th Plant M. Co., *Franklin R. Powers*
1903. This Drawing is the property of
AMERICAN OIL COMPANY and is to be used only by
the above named company.

FIG. 11—HEATING COILS FOR CREOSOTE, CHLORIDE AND TANNIN TANK.

Eleventh—Loading and unloading platform.

As the amount of material to be handled is great, and the timber is very heavy and unwieldy, every care must be taken to reduce this labor to a minimum. The elevated platform, conforming to the height of the floor of a car, has been found a very great help, the charge from the retort being run up an incline on to it and there unloaded into cars for outshipment.

Twelfth—Steam derrick. Where timber and piling are treated in connection with cross-ties, and the quantity justifies, a traveling steam derrick is very useful, especially with long piles and timber.

Where gondola cars are to be had for outgoing ties, the tram loads can be placed in them bodily.

Thirteenth—Tram cars or buggies, on which the timber is designed to be treated, or loaded, are compactly and strongly built, weight from 800 to 1,000 pounds each, and are provided with two curved arms on each side, conforming to section of the retort, and have a capacity of from 30 to 45 standard cross-ties, as they may be hewn or sawed. With length of tie eight feet, 12 to 14 cars make a charge, depending on length of the retort.

For long timber and piling a car of much the same dimensions, but provided with a strong bolster turning freely on the center of the tram, instead of the two pairs of arms, is used. The timber or pile is loaded on two cars and, by means of the bolster, the car can turn curves freely in the yard where curves are unavoidable in works of any extent.

Fourteenth—Scales for weighing timber.

As the amount of absorption of the chemicals in solution by the timber is of the first importance, any means necessary to determine this accurately should be employed. The indicator measurements is the one of main reliance in determining this, and to check this a four-ton platform scale, set in the tram track at a convenient point for weighing, is perhaps the best means to be devised. On this a tram load or a single piece can be weighed, first before treat-

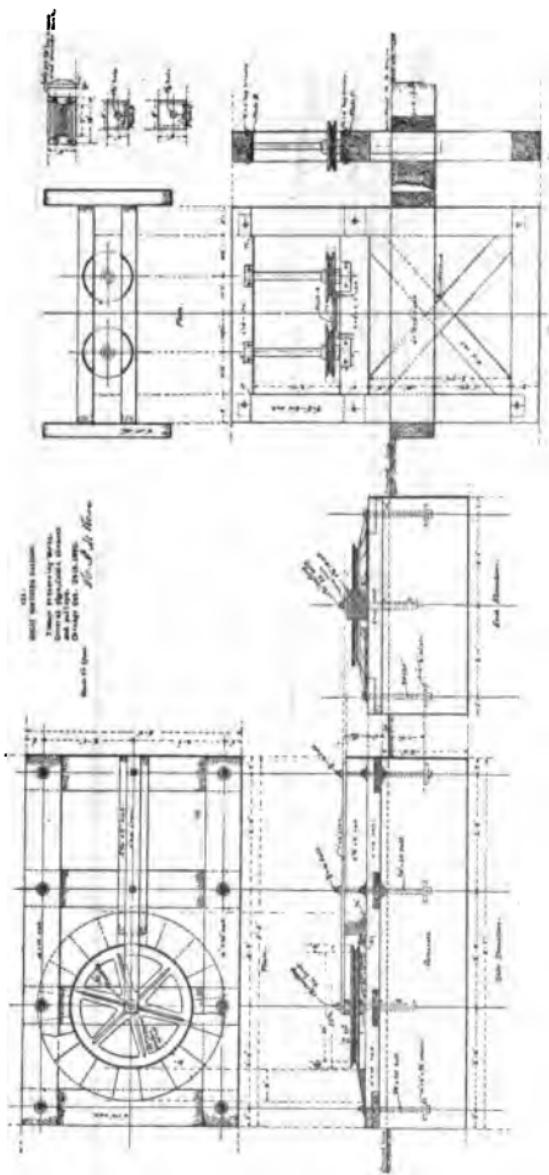


FIG. 12.—SHEAVES AND GUIDE PULLEYS.

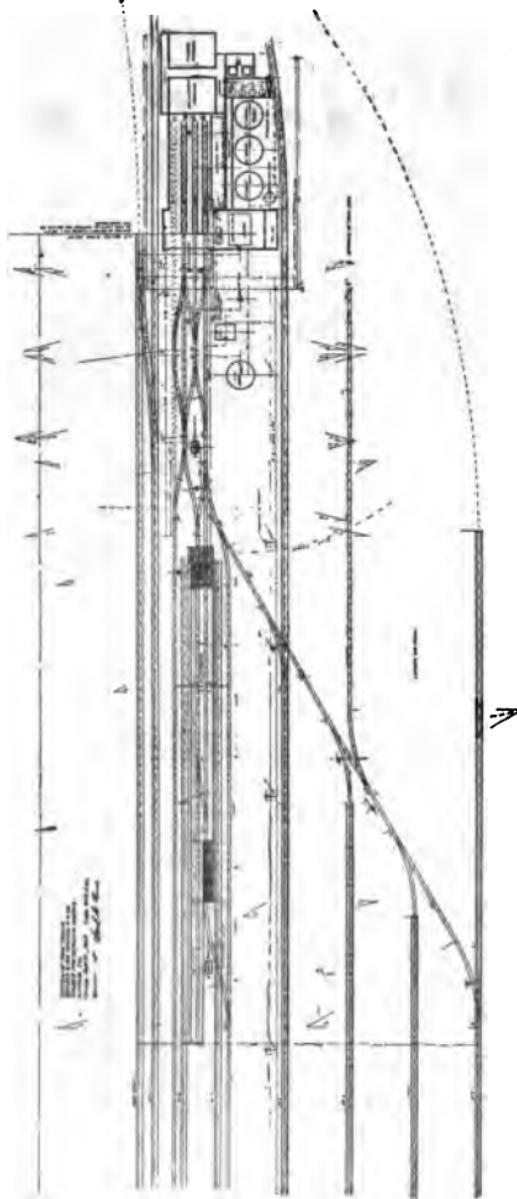
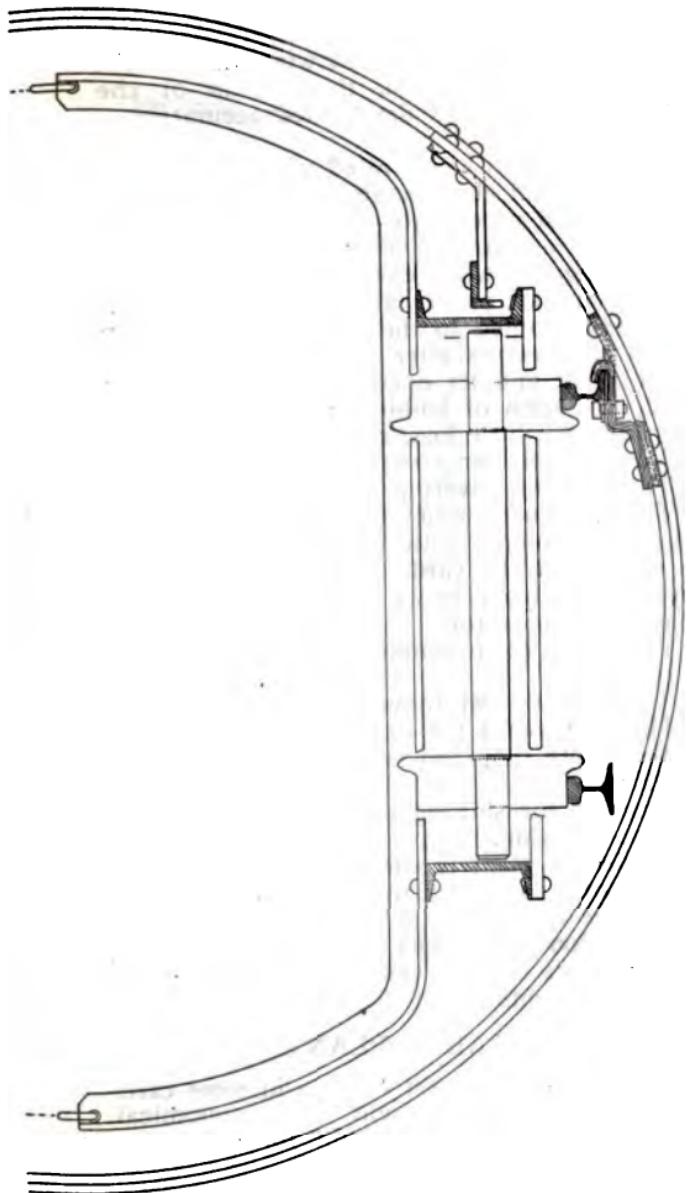


FIG. 13—TRAMWAYS (ALAMOSA YARD).



K.—
SECTION OF 78' RETORT, *WITH CAB.*—
Chambers 1st. deck.
1st. deck.
2nd. deck.

FIG. 14—RETOUR SECTION WITH CAB.

ing and again after, whereby knowing the weight and strength of the solution, the amount of the chemical absorbed, can be determined accurately.

Fifteenth—Buildings.

Where a plant is to be operated continuously day and night, and in all climates and kinds of weather, the buildings must necessarily cover and protect the machinery and appliances effectually. Ordinarily, wooden buildings or wood covered with corrugated iron on sides and tar paper, tar and gravel for roof, are found best adapted to the purpose. These can be made to effectually shelter the works, are cheap, and as the plant and its operation are not always permanent, this form of building is best adapted to easy removal, with little loss, if the necessity comes. The buildings particularly required are:

- (a) The building covering the retorts.
- (b) The machinery room, containing all pumps, valves and machinery, with the exception of the shifting engines in the yard. The machinery must be compactly arranged so as to be under the eye and hand of the operator.
- (c) The boiler room containing the boilers, feed pumps, etc.
- (d) The chloride vat room.
- (e) The storerooms for storage of chemicals.
- (f) Blacksmith shop and repairing room.
- (g) Office.
- (h) Housing for shifting engines.

Sixteenth—Lighting.

A small electric plant is almost indispensable. It may consist of a small steam engine operated by steam from the boilers and a dynamo good for ten arc lights of 1600 c. p. or its equivalent, furnishing four or five lights outside and any desired number of incandescent lights inside.

A PORTABLE PLANT.

A portable plant for timber treating in some cases will be found both convenient and economical. The retort is one of a pair built for the Union

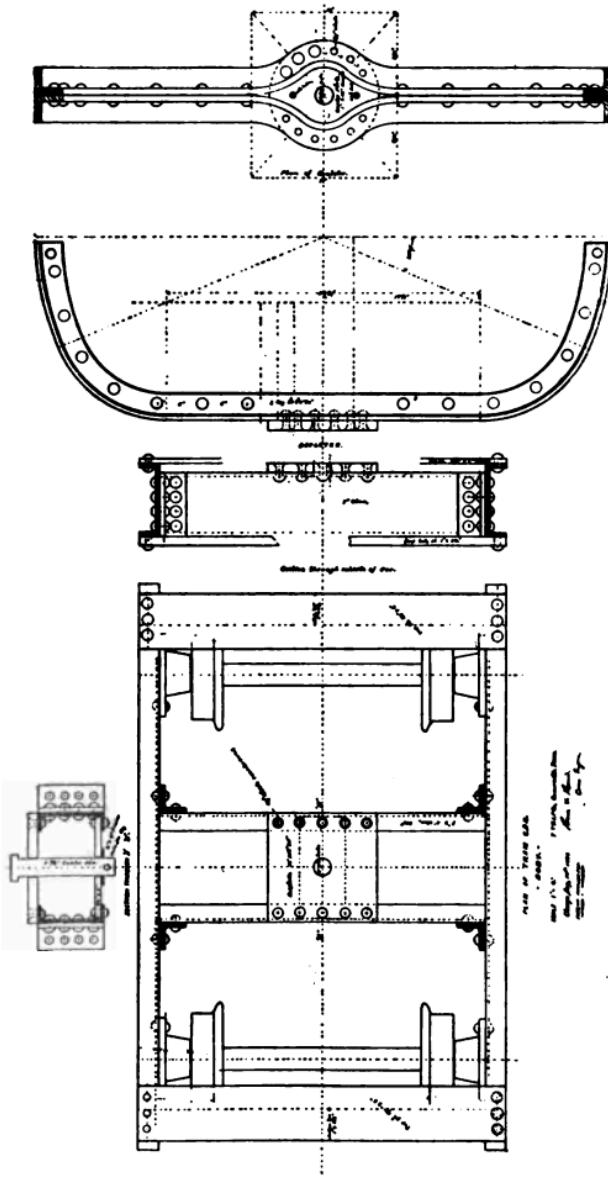


FIG. 16—BOLSTER CAR.

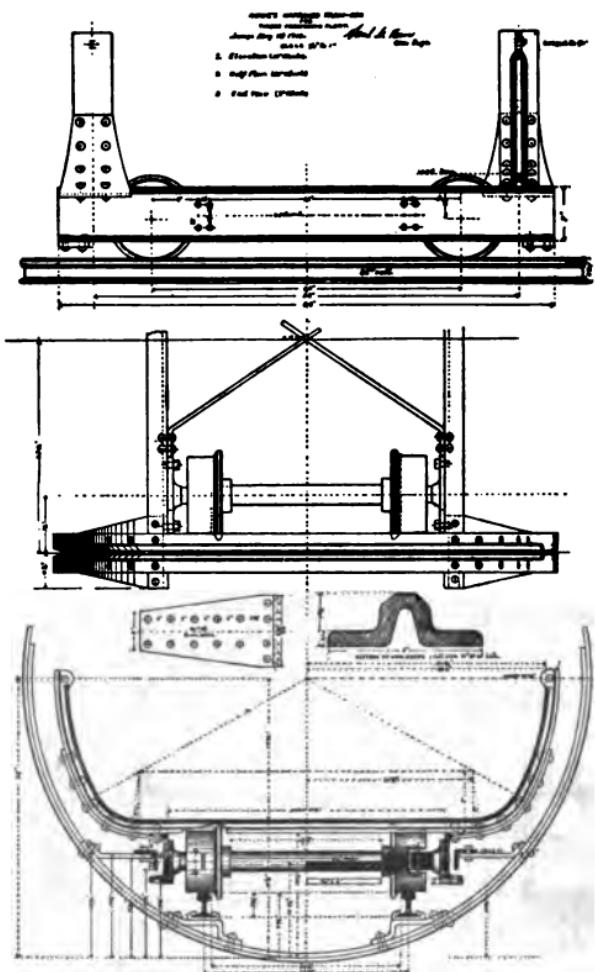


FIG. 16—BOWE'S IMPROVED TRAM OAR (BALL BEARING).

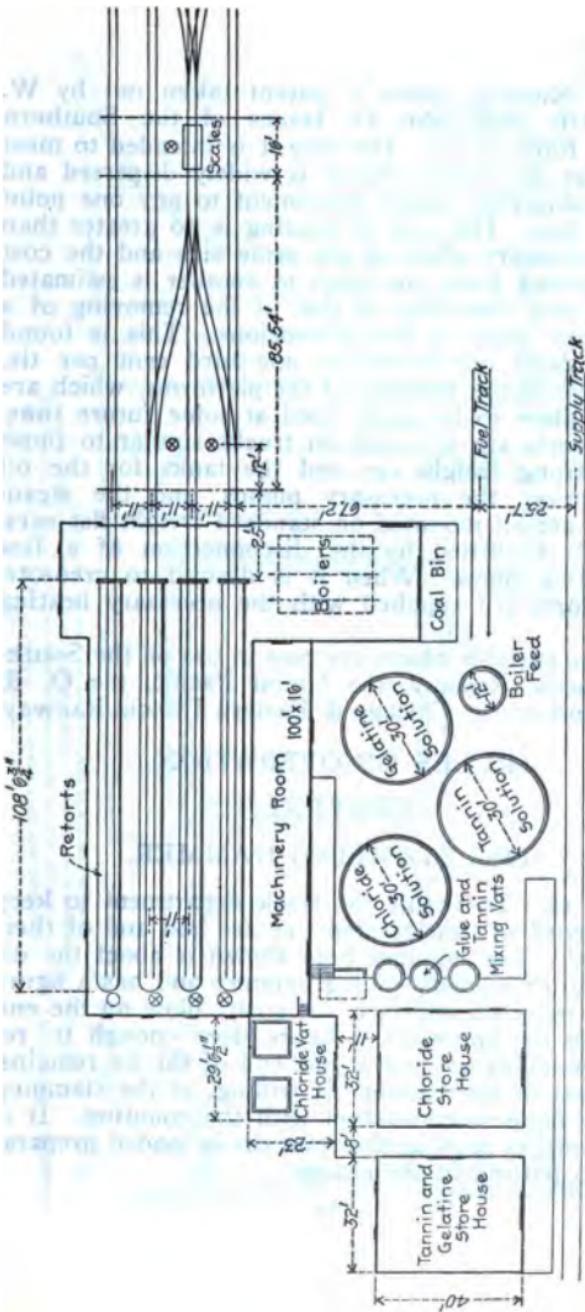


FIG. 17.—GENERAL LAYOUT OF BUILDINGS (G. N. BY).

Pacific Railway under a patent taken out by W. G. Curtis and John D. Isaacs of the Southern Pacific Railway Co. The case it is intended to meet is where the timber supply is widely dispersed and no considerable supply convenient to any one point on the line. The cost of treating is no greater than at a stationary plant of the same size and the cost of removing from one place to another is estimated at not over one-third of that of the removing of a stationary plant of like dimensions. This is found to be about one-fourth to one-third cent per tie, exclusive of the removal of the platforms, which are left in place to be again used at some future time. The retorts are mounted on trucks similar to those of a strong freight car and the tanks for the oil or solution, the necessary pumps, and the steam boilers are all mounted on standard freight flat cars, and all is shifted by the disconnection of a few connecting pipes. When it is desired to creosote, the retorts are supplied with the necessary heating coils.

Three portable plants are now in use on the Southern Pacific Railway, the Union Pacific, the O. R. & N. and on the Chicago & Eastern Illinois Railway.

RULES OF OPERATION.

GENERAL.

THE STAMPING HAMMER.

Sec. 12. To enable the track department to keep any record of time treated ties are laid and of their removal. The hammer here shown is about the dimension of a small spiking hammer and has a figure cut in relief on one face. A smart blow on the end of each tie impresses a figure deep enough to remain indelibly as long as the end of the tie remains. The cost of the hammer is trifling, as the stamping can be done in connection with the counting. It is best done as soon as the tram car is loaded preparatory to putting in the charge.

THIS VAT IS TO KEEP IN A GROWING STATE PLACED IN THE MIDDLE OF THE
HORNHOUSE OVER THE STORAGE PIT. ORGANICALLY THE VAT WILL HOLD APPROXIMATELY
TWO OR ALMOST TWO FT. DEEP. ABOVE IS NECESSARY THE CHAMBER CAN BE ADDED.
CHARGE DAY UPON DAY UP TO TWO MILLIMETERS. MEASUREMENT SHOULD BE AT MID POINT OF THE CHAMBER TO THE
SCALE, ETC., MEASURED DOWNTOWARD THE BOTTOM TWO OR THREE FEET OF THE CHAMBER ARE ANALYZED.

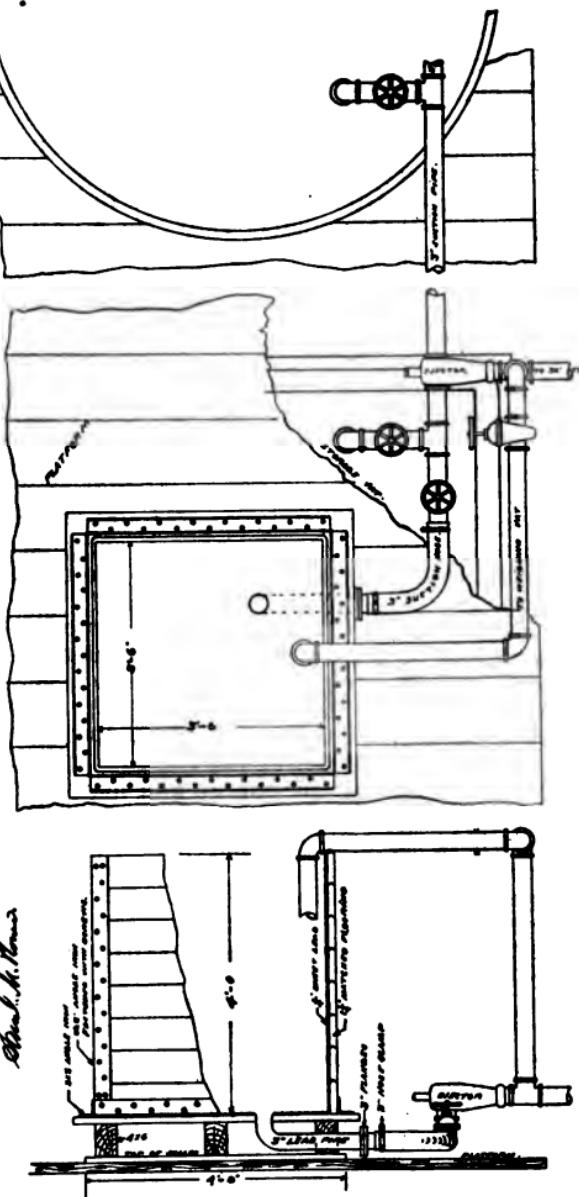


FIG. 18—WEIGHING VAT.

THE DATING NAIL.

The Dating nails here shown, suggested by Octave Chanute, C. E., are intended to be driven into the tie after it has been placed in the track. The best place seems to be on the line side of the track, say 12 inches from the line of the rail. The cost of the nail is approximately 2-10 cent each.

The main purpose of the nail does not preclude the use of the stamping hammer before introducing for treatment, which is considered as well worth doing even if dating nails are to be used.

In operations where the plant consists of one, two or three retorts, it is usual to start the charges about an hour apart, so that the use of compressor and vacuum pump will not interfere and can be applied to each retort in turn; thus all three retorts can be operated by the one machine. If the plant has more than three retorts, say four or six, then a second compressor and vacuum pump will be required, and the retorts can and should be run in pairs.

Each retort requires its own force or pressure pump and its separate system of piping for solution, steam and air, so arranged as to serve each retort in its turn.

The details of operation, more specifically given, are divided about as follows:

(a) Preparing the charge and manner of loading the timber.

As it is essential that the steam and the solution, each in its turn, shall have free access to all sides of the timber (each piece), a space must be left or reserved for this, especially for sawed stuff, otherwise the operation will be greatly impeded or entirely defeated.

A compactly loaded mass of timber will act much as if it were still unsawed. This has been exemplified in the nine-foot retort, where, even with quarter-inch iron strips between, the steaming requires from three to four times as long a time as that required where the pieces are properly separated, and the

STEEL RIES FOR STAMPING GROOSES-THESE ONE HUNDRED STANDARD ONE-LARGE MARKS PER YEAR ARE FOR 1000' AND 10000' LINES (1000' IS APPROXIMATELY FOR THE SMALL, 10000' IS APPROXIMATELY FOR THE LARGE). THE STANDARD SCHEDULE IS APPROXIMATELY 10% OVERHEAD. THE OVERHEAD IS APPROXIMATELY APPROVED BY THE STATE, THE STATE SHOULD BE AND IS ADVISED TO APPROVE THE SCHEDULE FOR THE STATE. THE STATE MAY APPROVE OR DENY THE SCHEDULE, OR APPROVE OR DENY THE OVERHEAD.

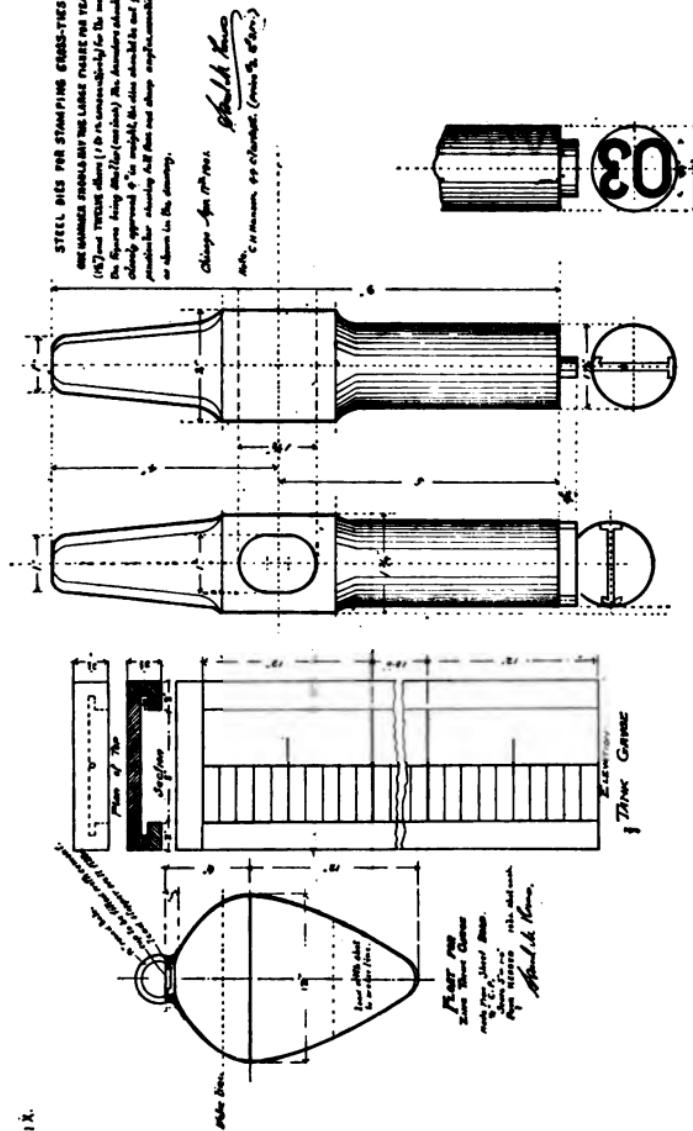


FIG. 19—STAMPING HAMMER INDICATOR, BOARD AND FLOAT.

DATING NAIL FOR TIES.

FULL SIZE.

03

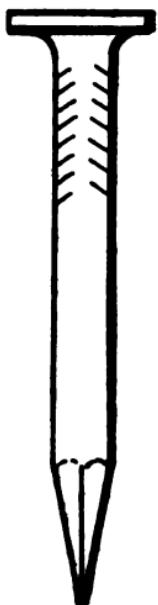


FIG. 20—DATING NAIL.

same is true as to pressure on solution. A one-inch strip, or an ordinary barrel stave, will do with sawed ties. Hewn ties do not need this.

In loading, the ties should be arranged to conform to the loading gauge, so that there will be no interference in charging, and there firmly chained, care being taken to have the load even at the ends so as to allow the inspector easy access for counting and stamping.

The stamping die should be a hammer about the weight of a small railroad spike maul, weighing three and a half to four pounds, with handle similar and with the die full faced and deeply cut (three-eighth inch), vertical and not tapering, securing an impression deep enough to last as long as the timber itself.

The loaded cars are then assembled to make the proper charge, and are then, by means of the shifting engine, cables and pulleys, drawn into the retort, the doors closed and sealed, when all is ready for:

(b) Steaming.

The steam is introduced into the retort, preferably at each end and nearly at the bottom. Meanwhile the blow-off at the top of the retort is kept open to allow the air to escape until the retort is full of steam. When the retort is entirely filled, the blow-off is closed and the steam is accumulated until it has reached a pressure of twenty pounds per square inch and there held throughout the entire remaining time required—four to six hours. This pressure is fixed as the maximum, as the temperature of the steam is then at near 250 degrees Fah., about all that the timber will bear without scorching and injury to its fiber. Frequently during the steaming, the condensations should be drawn off from the retort, by means of the automatic blow-off, to the sewer, accelerating the dryness of the steam and reducing condensation, and securing greater dryness in the timber after the vacuum is drawn. The steam is then blown off, being discharged into the air.

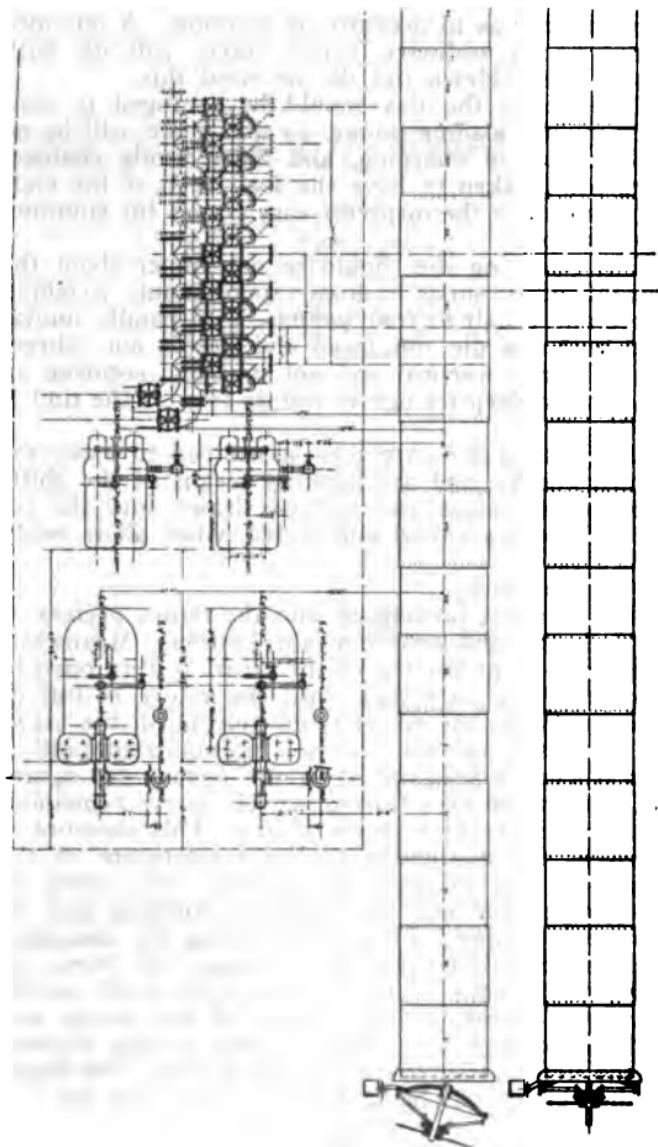


FIG. 21—SOLUTION PIPES (TENTATIVE PLAN 8 REPTORT WORKS).

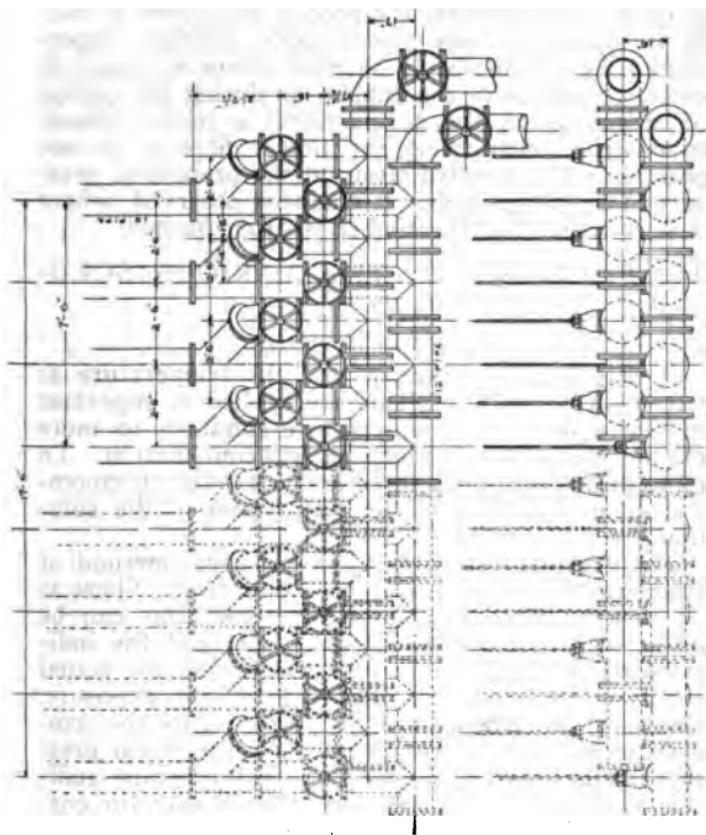


FIG. 22—SOLUTION PIPES AND VALVES (8 RETORT WORKS).

SUPERHEATED STEAM IN CONNECTION WITH TIMBER TREATMENT.

There can be no doubt as to the utility and economy in the use of superheated steam for heating the solution or oils used where the steam is used in coils, as it expedites the process and saves in fuel. It is, however, very questionable whether superheated steam can safely be used where it comes in direct contact with the timber, as during the period of steaming, as the temperature is more difficult to control, endangering the timber fibre as is not possible with saturated steam at the prescribed pressure of twenty pounds. It has been observed, where it is so used, that the timber is often burned.

TEMPERATURE IN THE VARIOUS SOLU- TIONS.

(Thermometers.)

It is generally conceded that the temperature at which the various solutions are applied is important in that a quite high temperature conduces to more prompt chemical action and perfect combination. To more perfectly control this, the Fahrenheit thermometer is applied both to the retorts and to the solution reservoirs or tanks.

The drawing herewith shows the usual method of attaching the thermometer to the retorts. There is no way by which more perfect connection can be made with the contents of the retort and the indicated temperature will be somewhat below the actual mean of the reservoirs until after long exposure. The most important function is to measure the temperature of solution or oils as with the steam pressure gauge will give the heat of the steam sufficiently close. A few observations will give the correction to be added, approximately at least. In any case the approximate will be a fair guide in absence of any means of obtaining exact readings.

(c) The vacuum.

When the steam is fully blown off the retort

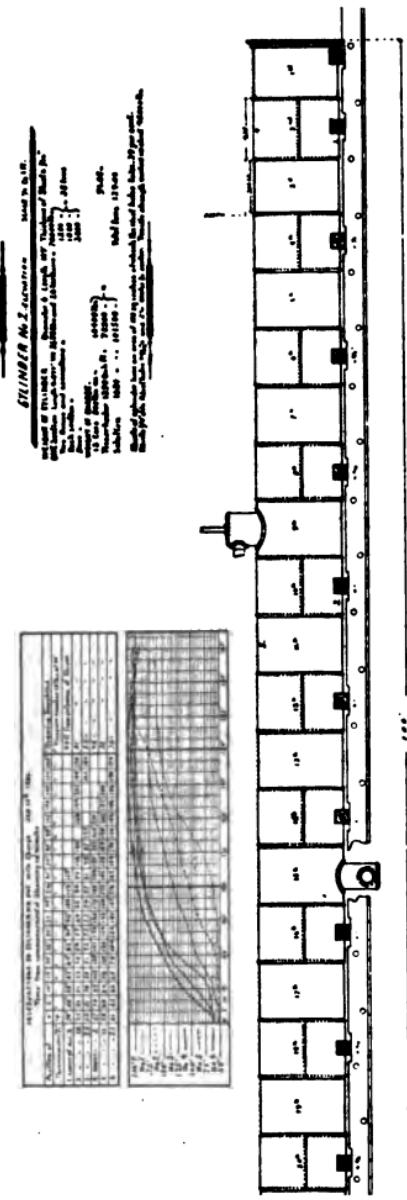


FIG. 22—RETORET NO. 2 (LAS VEGAS).

Showing how entrance of steam at the top of the retort expanded, the stud plates causing rupture of the sheets at the bottom. The diagrams indicate the temperature of the sheet at six different points during the steaming of the charge.

should be allowed to cool for a little time, the circulating water should be started through the surface condenser and allowed to flow, insuring the greatest degree of cold surface to the hot vapors from the retort before the vacuum pump is started, thus preventing these hot vapors from injuring the valves of the pump.

In a one or two retort plant, one of the force pumps can be utilized for pumping the circulating water; but in a large plant, either the service and fire pump will answer, or a special pump will be necessary.

Thus having cooled the condenser, the vacuum is drawn, raising it as fast as is practicable to 20 at 26 inches, and there holding it for half an hour or more, if desired. If the hot-well catching the condensation fills so that the contents are thrown off through the vacuum pump, and it is desired to measure it, resort must be had to an auxiliary reservoir, so arranged as to receive the surplus when necessary. The practicability of measuring these condensations with a view to determine the amount of sap extracted from the timber, is a matter of doubt, and will be noticed further on.

A marked advantage has been secured in treating obdurate timber (dense, wet or green), by interposing a vacuum at an intermediate time during the steaming, blowing off the latter, drawing a vacuum and again introducing the steam while the vacuum is still held. This idea is worth investigating when opportunity offers.

(d) Introducing the chloride solution.

The vacuum having been on for sufficient time, it is still held, and the valve in the solution pipe is opened and the solution allowed to flow in, which it does very rapidly by the help of the vacuum, until the retort is entirely filled, the air pipe being opened to allow the escape of the remaining air in the retort and then closed.

The solution should be heated from 80 to 100 degrees Fah. before introduced, as it is found that the

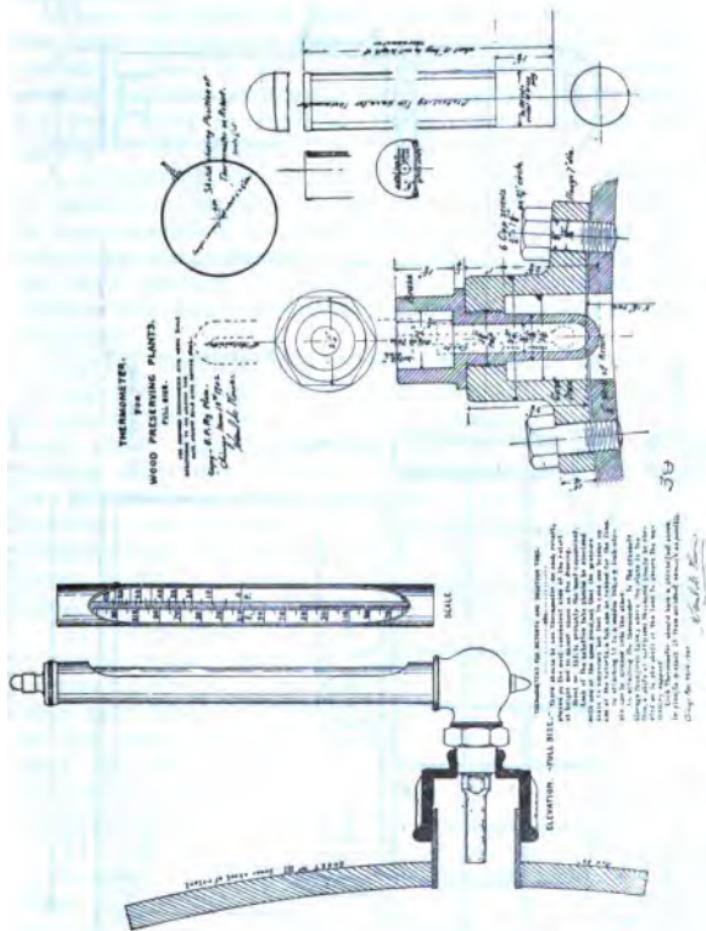
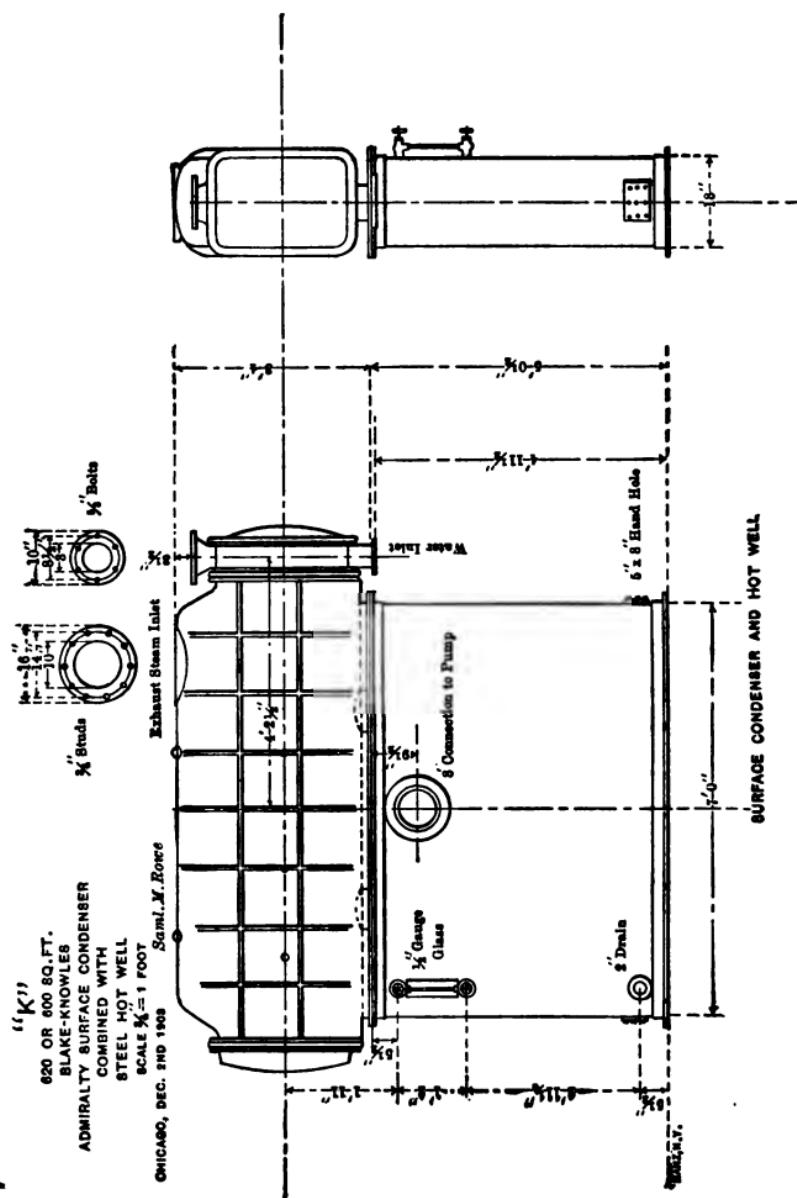


FIG. 25—THERMOMETERS, SHOWING METHOD OF ATTACHMENT.



SURFACE CONDENSER AND HOT WELL

FIG. 26.—CONDENSER AND HOT-WELL.

chloride is held best in suspension at about that temperature.

When the retort is filled and the air pipe closed, the force or pressure pump is at once started and the pressure raised to 100 pounds per square inch, which should be done in a very short time, and there held for such time as shall be judged best to meet the nature of the timber.

A measuring vat, in which the estimated quantity of solution that the charge should receive is held, is recommended by some as a good thing, as, by attaching the suction of the pressure pump to the vat and running it until the vat is exhausted, the timber will have absorbed the proper amount of the solution.

Careful reading of the indicator about the time the pressure from the pump begins, and then again at times during which pressure remains, will give a very close measurement of the amount absorbed during that time, but of course there is no means of determining how much was absorbed before pressure was secured. The indicator reading before introducing and again after forcing back, gives the most accurate measurement possible, except, perhaps, the weighing before and after.

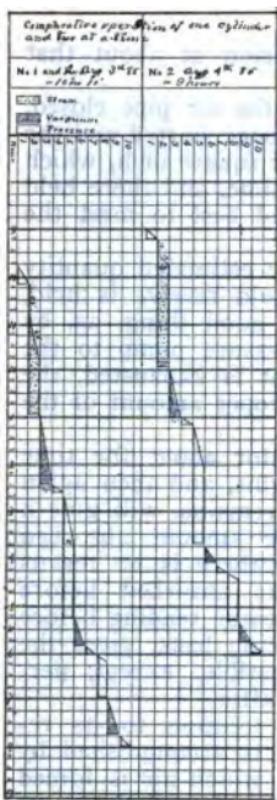
(e) Returning the chloride solution to its receptacle is the next move, and is accomplished by means of the air compressor by which air is forced into the retort. When it is quite cleared the valve in the main solution pipe is closed, and the blow-back is used to clear the retort of the last remnant of solution, which is carried to its proper tub by an overhead pipe.

(f) Introduction of the tannin solution.

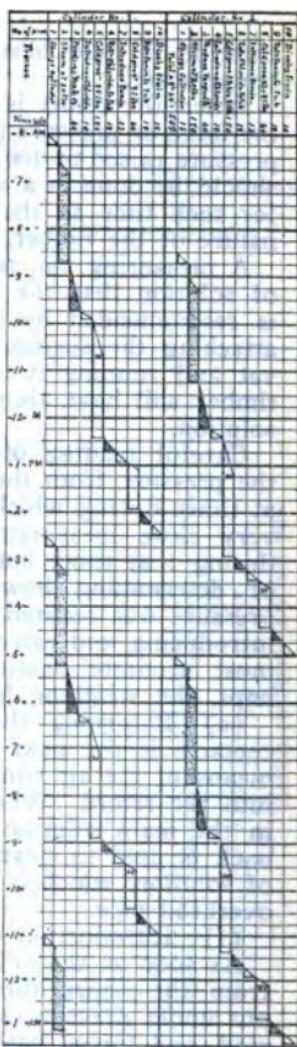
As soon as the chloride solution has been cleared from the retort, the tannin solution is introduced, put under pressure and so held for the desired period, and forced back to its receptacle in every respect as with the chloride, except that the time held under the pressure of 100 pounds need not be so long, as the action of the tannin is quite superficial.

Timber Treatment Chart.

• 30 •



Aug 10th 1885 dark room



Steam,
 Vapour,
 Cold pressure,
 Hot pressure

Samuel Lowe
1885 K6

FIG. 27—ORIGINAL DIAGRAM OF BUNS (LAS VEGAS, 1885).

This completes the operation. The doors being opened, the charge is removed from the retort. The next charge being prepared is run in, the doors are closed, and the whole program is repeated. A charge takes from 10 to 12 hours.

RULES FOR MIXING CHEMICALS.
ZINC-TANNIN OR WELLHOUSE PROCESS.
CHEMICALS USED.

Chloride of Zinc. ($ZnCl_2$.)

Sec. 13. The principal antiseptic agent used in this process is the chloride of zinc. The chloride can be made on the ground by the combination of hydrochloric acid (muriatic) with common metallic zinc, or the commercial product in the form of a salt furnished in large drums or rolls protected by a covering of thin sheet iron. There is but little difference in the cost, the difference being in favor of the commercial article.

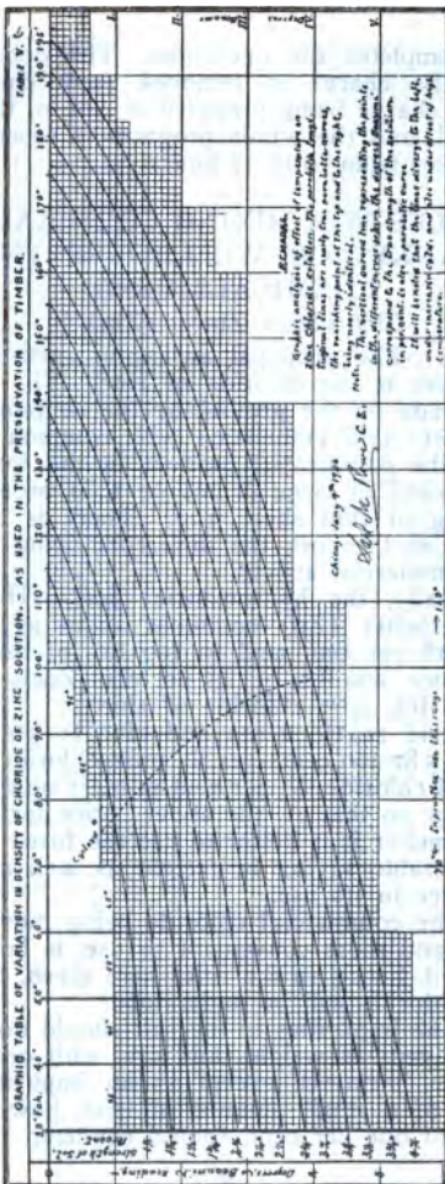
Empirically, the hydrochloric acid (HCl) and the zinc spelter (Zn) combines about as follows: 350 lbs., 18 per cent acid to 100 lbs. of the spelter will produce 409 lbs. of 45 per cent $ZnCl_2$, equal to about 185 lbs. pure chloride of zinc.

With acid at $1\frac{1}{2}$ cents and zinc at 56-10 cents would be 587-100 cents per lb. pure chloride of zinc. The fused chloride, 98 per cent pure, is now sold for four cents, so that at the above price for the acid and the spelter it is better to use the fused chloride, at considerable saving in freight as well as in the convenience in its use.

(c) The commercial chloride being most readily obtained and more convenient to use, is being generally used, hence, in the rules here given, the commercial chloride will be understood.

(d) The impurities in the salt should not exceed three per cent in weight, and are, with one exception, quite harmless, except as an impurity. The presence of a small amount of iron, however, say one-half of one per cent, should condemn it, as the

FIG. 28—GRAPHIC TABLE, DENSITY OF CHLORIDE OF ZINC.



iron neutralizes the chloride and at the same time is said to injure the wood fiber.

(e) The commercial salt will often have a small amount of free, uncombined acid, which is destructive to wood fiber if present in any great amount, hence the dissolving as well as the storage vat should contain a liberal allowance of the zinc blocks to take it up, and the time allowed for its action should be as extended as possible.

(f) A graphic table of weight and specific gravity of chloride of zinc is here given, which gives the data on which the table for quantities, in Table "B," is computed. While it is not claimed to be exact, yet it gives a sufficiently close approximation and serves the purpose. It is the summing up of numerous trials.

PREPARATION OF CHEMICALS FOR USE.

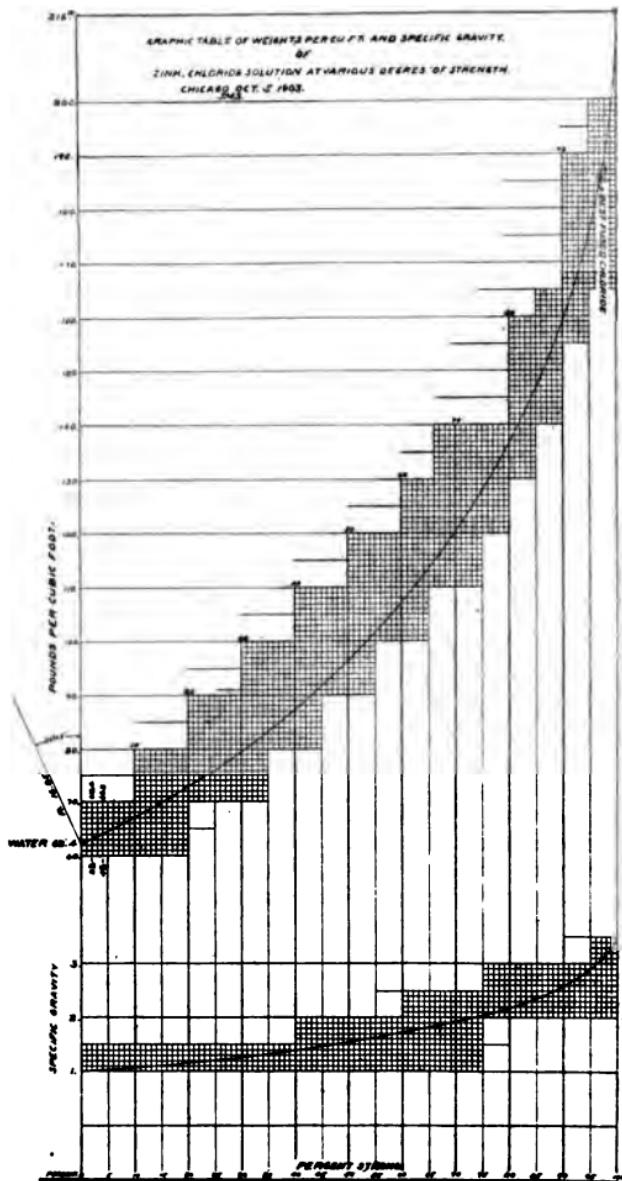
Sec. 14. The chloride of zinc.

(a) Dissolving: The fused chloride (commercial) should be dissolved into stock solution, a concentrated solution from 35 to 50 per cent strong, some little time before used, say 24 hours if practicable, so that it shall be thoroughly dissolved, and that any free acid it may contain will have time to be taken up by the spelter (zinc) kept in the dissolving vat for that purpose.

The drums or rolls of fused chloride should then be divested of the iron covering, weighed, and if the works are provided with a trolley carrier, be placed bodily in the dissolving vat, or in absence of the trolley, they should be broken into smaller fragments and dropped from planks placed over the vat, which should have been previously partially filled with water. In placing the pieces in the vat, care must be taken that the lead lining of the vat be not injured.

(b) The following will guide as to the amount of the salt to be weighed in, and as to the amount of water for dissolving. First fill vat about half

FIG. 29—GRAPHIC TABLE, WEIGHT OF CHLORIDE OF ZINC.



full, and then add the chloride and fill with water to the height indicated:

For 35 per cent stock solution—

6,296 pounds salt, and fill to 2.2 vertical feet.

For 40 per cent—

7,865 pounds salt, and fill to 2.3 vertical feet.

For 45 per cent—

9,285 pounds salt, and fill to 2.3 vertical feet.

For 50 per cent—

10,860 pounds salt, and fill to 2.3 vertical feet.

(c) This computation is based upon a mixing vat ten feet square and two and one-half feet deep, and, being lead lined with half-inch sheet lead, has approximately an area of 99.4 square feet.

The above is a fair guide, remembering that the exact amount of the salt or the resulting strength of solution is not essential, as any intermediate strength can be used by the same means of computation.

A solution of from 40 to 50 per cent is about the most convenient.

(d) When this stock solution is well neutralized and dissolved, it is drawn off into the storage vat, a lead-lined vat the same as the mixing vat, except in dimensions. This vat is provided with a steam ejector by which the concentrated stock solution is forced into the solution tub or tank through a discharge pipe passing over the top and there discharging.

PREPARATION OF DILUTED TUB SOLUTION.

Sec. 15. (a) Assuming the size of the storage vat to be 8 by 12 feet, area being 96 feet, and the solution tub being 30 feet in diameter, wood and iron bound, with a mean area of 664 square feet, then we have for putting up the stock chloride from storage vat to the diluted solution tub, Table "B," giving the number of cubic feet of stock solution for each tub foot required, hence by multiplying this by the number of tub feet to be charged, and dividing the

result by the area of the storage vat (96 sq. ft.), gives the vertical feet to put up.

Dilution of Chloride Solution.

(b) To make up the first tub of solution, say two per cent strong, fill solution tub with water to, say 17 feet, the tub being 20 feet deep, each tub foot being equal to 664 cubic feet (mean area of tub) by 17 vertical feet, equal 11,288 cu. ft. multiplied by 62.3 lbs. (weight of cu. ft. of water) equals 703,242 lbs. water.

Then as 98 per cent of water is to the two per cent of chloride, so is 703,242 lbs. of water to 14,352 lbs. pure chloride required.

Then for cubic feet in volume of the two per cent chloride we have: Water, 703,242 lbs., which divide by 62.3 lbs. equals 11,288 cu. ft., and chloride, 14,352 lbs., which divide by 200.0 lbs., equals 71.76, making total of 11,359.76 cubic feet, or about 17.2 vertical or tub feet.

DETERMINING STRENGTH OF CHLORIDE SOLUTION.

(c) No more satisfactory means have been found for testing the strength of the chloride solution than the Beaumé Hydrometer, using the coarse hydrometer, one to sixty degrees for the concentrated and the fine hydrometer, one to six degrees, divided to 1-10th degree, for the highly diluted solutions. In the heavier solutions, say 30 to 60 degrees, the influence of temperature is small, so that no account need be made for it, but with that highly diluted it is necessary to define the effect of temperature very carefully to get true measurement of strength.

To meet this, the table (A), Figs. 32, 33 and 34, has been prepared by means of empiric tests subjected to a law of curve developed by trial, by which a close approximation has been made. Comparison of calculated quantities used in one month's run, with the actual quantity of stock used, has served to confirm the exactness of the tables.

Figs. 30 and 31 give the same graphically, the curves described being true spirals both as to the variation under increased heat and for the points at which the per cent of strength agrees with the degrees Beaumé.

The use of the hydrometer is impracticable with the glue and the tannin solution, either being about the same specific gravity as water.

WATER FOR DILUTION.

Sec. 16. It is here proper to notice the character of the water to be used in this connection in making up the chloride solution.

In carrying through the process, a considerable quantity of water, variously estimated at 15 to 25 thousand gallons per day per retort, including the supply for steam and circulating purposes as well, is used. Pure water is very desirable and its quantity is important, for, should it be bounteous, much may be saved in water saving appliances. There are some locations where it is desirable to locate works that the quantity is meager and the quality is poor.

GELATINE (Glue).

Sec. 17. Commercial glue of good quality contains the gelatine which, under the Wellhouse process, forms a part of the plugging up substance by its combination with the tannin. Glues vary considerably in the amount of gelatine contained, but 60 per cent is supposed to be a fair estimate for a good commercial article.

(a) The per cent in weight of water at 60 degrees Fah. that any glue will absorb, is said to be about the best test of quality. A first-class glue, it is said, will absorb 13 parts of water to 1 of glue, but it is found that some of the best cabinet glues will not take over 5 or 6 in the 24 hours' test.

(b) It has been, and now is, the practice to use a solution in combination with the chloride consisting of one-half of one per cent of the total in glue.

FATHOMETER READING.

		FATHOMETER READING.																			
		1	2	3	4	5	6	7	8	9	80° /	2	3	4	5	6	7	8	9	90° /	
5 ft.	70° /	1	1.09	1.08	1.06	1.04	1.02	1.01	0.99	0.97	0.96	0.93	0.91	0.89	0.88	0.86	0.83	0.81	0.77	0.75	
1/2 "	1.11	1.10	1.09	1.08	1.07	1.06	1.05	1.04	1.03	1.02	1.01	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	
1/4 "	1.41	1.40	1.39	1.37	1.36	1.35	1.34	1.32	1.29	1.27	1.25	1.22	1.21	1.19	1.17	1.15	1.13	1.11	1.09	1.07	
1/8 ..	1.71	1.70	1.69	1.67	1.65	1.63	1.61	1.60	1.58	1.56	1.54	1.52	1.50	1.48	1.46	1.45	1.43	1.41	1.39	1.37	
1/32 "	2.01	2.00	1.99	1.97	1.94	1.93	1.91	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.76	1.74	1.72	1.71	1.69	1.67	
2 %	2.31	2.30	2.29	2.27	2.24	2.23	2.21	2.20	2.18	2.16	2.14	2.12	2.10	2.09	2.07	2.05	2.02	2.01	1.99	1.97	
2 1/2 "	2.61	2.60	2.58	2.56	2.54	2.52	2.50	2.49	2.47	2.45	2.43	2.41	2.39	2.38	2.36	2.34	2.32	2.30	2.28	2.24	
2 1/4 "	2.91	2.90	2.88	2.86	2.84	2.82	2.80	2.78	2.76	2.74	2.72	2.71	2.69	2.67	2.65	2.63	2.61	2.59	2.57	2.55	
2 3/4 "	3.21	3.20	3.18	3.16	3.13	3.11	3.09	3.07	3.05	3.04	3.02	3.00	2.98	2.96	2.94	2.92	2.90	2.88	2.86	2.83	
3 %	3.50	3.49	3.47	3.46	3.44	3.41	3.39	3.37	3.35	3.33	3.31	3.29	3.27	3.25	3.23	3.21	3.19	3.17	3.15	3.12	
3 1/4 "	3.81	3.79	3.76	3.74	3.72	3.70	3.68	3.66	3.64	3.62	3.60	3.58	3.56	3.53	3.51	3.49	3.47	3.45	3.43	3.41	
3 1/2 "	4.10	4.08	4.05	4.02	4.01	3.99	3.97	3.95	3.93	3.90	3.88	3.86	3.84	3.81	3.79	3.77	3.75	3.73	3.70	3.68	
3 3/4 "	4.40	4.37	4.35	4.33	4.31	4.28	4.26	4.23	4.21	4.19	4.17	4.15	4.12	4.10	4.07	4.05	4.03	4.01	3.98	3.96	
4 %	4.69	4.66	4.64	4.62	4.60	4.59	4.55	4.52	4.50	4.48	4.45	4.43	4.40	4.38	4.36	4.33	4.31	4.29	4.26	4.24	

TABLE I. Temperature 80° / from 70° / to 90° / and one to 9% farenheit.

Notice. These tables are compiled from the results of long and careful investigations and study by the author therefore all rights are reserved and copyright will be applied for at Chicago, April 4, 1900.
At G. M. Hall,
and G. M. Hall

FIG. 82—TABLE "A" NO. 1.

Fahrmann Ther. Reading.											
Grain per cent.	90°	1	2	3	4	5	6	7	8	9	10°
1%	0.75	0.72	0.70	0.67	0.65	0.62	0.60	0.57	0.54	0.51	0.49
1 1/4%	1.02	1.00	0.97	0.95	0.92	0.90	0.87	0.84	0.82	0.80	0.77
1 1/2%	1.32	1.30	1.27	1.25	1.23	1.20	1.18	1.15	1.12	1.10	1.07
1 3/4%	1.62	1.60	1.58	1.56	1.53	1.51	1.48	1.45	1.43	1.40	1.38
2%	1.92	1.90	1.87	1.86	1.84	1.81	1.79	1.76	1.74	1.72	1.70
2 1/4%	2.24	2.21	2.19	2.17	2.15	2.13	2.10	2.07	2.05	2.03	2.01
2 1/2%	2.52	2.50	2.48	2.46	2.44	2.42	2.39	2.37	2.34	2.32	2.30
2 3/4%	2.81	2.80	2.78	2.76	2.72	2.71	2.69	2.67	2.64	2.62	2.60
3%	3.10	3.09	3.07	3.04	3.01	3.00	2.97	2.96	2.93	2.91	2.89
3 1/4%	3.38	3.36	3.34	3.31	3.29	3.27	3.25	3.23	3.20	3.18	3.15
3 1/2%	3.66	3.64	3.61	3.59	3.57	3.54	3.52	3.49	3.46	3.44	3.41
3 3/4%	3.93	3.91	3.89	3.86	3.83	3.81	3.79	3.76	3.73	3.71	3.69
4%	4.21	4.19	4.16	4.13	4.11	4.09	4.07	4.05	4.03	4.00	3.99

HYDROMETRIC READING

F	1	2	3	4	5	6	7	8	9	10
1%	0.49	0.46	0.43	0.40	0.37	0.34	0.31	0.28	0.25	0.21
1 1/4%	0.59	0.65	0.62	0.59	0.56	0.53	0.50	0.47	0.44	0.41
1 1/2%	0.68	0.74	0.71	0.68	0.65	0.62	0.59	0.56	0.53	0.50
1 3/4%	0.77	0.83	0.80	0.77	0.74	0.71	0.68	0.65	0.62	0.59
2%	0.86	0.92	0.89	0.86	0.83	0.80	0.77	0.74	0.71	0.68
2 1/4%	0.95	1.02	0.99	0.96	0.93	0.90	0.87	0.85	0.82	0.79
2 1/2%	1.04	1.11	1.08	1.05	1.02	0.99	0.96	0.93	0.90	0.87
2 3/4%	1.13	1.20	1.17	1.14	1.11	1.08	1.05	1.02	1.00	0.97
3%	1.22	1.29	1.26	1.23	1.20	1.17	1.14	1.11	1.08	1.05
3 1/4%	1.31	1.38	1.35	1.32	1.29	1.26	1.23	1.20	1.17	1.14
3 1/2%	1.40	1.47	1.44	1.41	1.38	1.35	1.32	1.29	1.26	1.23
3 3/4%	1.49	1.56	1.53	1.50	1.47	1.44	1.41	1.38	1.35	1.32
4%	1.58	1.65	1.62	1.59	1.56	1.53	1.50	1.47	1.44	1.41

TABLE II.—From 90° F to 110° for each Deg.

DIRECTION. Take average sample of solution, take temperature and hydrometer reading, then find the latter under the former, and the column of strong at the left of the Table will give the true strength.

FIG. 33.—TABLE "A" NO. 2.

TABLE III - 30° to 70° F. Fahrenheit Therm. Reading												TABLE IV - 110° to 176° F.																			
	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°	125°	130°	135°	140°	145°	150°	155°	160°	165°	170°	175°	176°
1%	1.50	1.47	1.42	1.39	1.35	1.30	1.25	1.19	1.11	1%	0.18	0.14	0.00																		
1 1/4%	1.84	1.81	1.78	1.77	1.66	1.61	1.56	1.49	1.41	1 1/4%	0.56	0.32	0.13	0.00																	
1 1/2%	2.18	2.15	2.08	2.03	1.98	1.92	1.86	1.79	1.71	1 1/2%	0.82	0.67	0.49	0.30	0.08	0.00															
1 3/4%	2.82	2.49	2.41	2.35	2.29	2.24	2.17	2.10	2.01	1 3/4%	1.16	0.86	0.81	0.61	0.41	0.18	0.00														
2%	2.86	2.80	2.74	2.69	2.64	2.56	2.48	2.40	2.31	2%	1.46	1.31	1.16	0.99	0.80	0.60	0.39	0.13	0.00												
2 1/4%	3.10	3.14	3.06	3.00	2.92	2.86	2.79	2.70	2.61	2 1/4%	1.76	1.61	1.46	1.29	1.12	0.92	0.72	0.52	0.29	0.00											
2 1/2%	3.44	3.38	3.32	3.24	3.17	3.09	3.00	2.91	2%	2.06	1.96	1.77	1.60	1.43	1.25	1.07	0.82	0.62	0.00												
2 3/4%	3.82	3.76	3.64	3.58	3.48	3.40	3.21	3.21	2 3/4%	2.32	2.20	2.07	1.90	1.75	1.57	1.38	1.17	0.95	0.00												
3%	4.18	4.10	4.03	3.95	3.87	3.79	3.70	3.64	3.50	3%	2.66	2.60	2.38	2.21	2.07	1.90	1.71	1.52	1.32	0.00											
3 1/4%	4.44	4.37	4.27	4.18	4.10	4.01	3.90	2.81	3 1/4%	2.91	2.76	2.62	2.54	2.33	2.16	1.98	1.79	1.59	0.35	0.00											
3 1/2%	4.86	4.78	4.67	4.59	4.60	4.41	4.31	4.20	4.10	3 1/2%	3.17	3.02	2.87	2.79	2.58	2.42	2.24	2.06	1.86	0.75	0.00										
3 3/4%	5.20	5.12	4.99	4.91	4.81	4.73	4.61	4.50	4.40	3 3/4%	3.43	3.29	3.14	3.08	2.84	2.68	2.51	2.33	2.15	0.97	0.00										
4%	5.57	5.43	5.32	5.22	5.12	5.02	4.90	4.80	4.69	4%	3.69	3.53	3.49	3.24	3.10	2.94	2.78	2.60	2.40	1.28	0.00										

FIG. 34—TABLE "A" NO. 3.

The tannin solution, containing the same amount of tannin extract which will combine in about equal parts, forming with the glue the leathery substance in the wood pores.

(c) The specific gravity of a fair glue should be, when perfectly dry, about 1.42, and should readily take six times its weight of water when immersed in it at 60 degrees Fah. for 24 hours.

To determine the specific gravity of any sample of glue, take a graduated tube, say a 200 c. cm. measure. First put in 100 c. cm. water, then weigh out one ounce of the dry glue and drop it into the tube, noting, immediately, the point to which the water is raised by the addition of the glue. The difference in the height of the water in the tube before and after adding the glue, will be the volume of the one ounce of glue in cubic centimeters, from which its weight and specific gravity can at once be computed.

(d) Then to determine the amount of water it will absorb, add to the above another 100 c. cm. of water, place it in a place where the temperature is constant at 60 degrees Fah. for 24 hours, when the proportion of water unabsorbed will appear clearly to the eye. Note this in c. cm. and divide by the whole 200 c. cm. of water, thus determining the proportion absorbed.

(e) In a one-half of one per cent solution of glue, the specific gravity will be inappreciably greater than pure water, so that the only means of determining its strength is to carefully weigh in the dry glue whenever the solution is renewed, the quantity of glue being always the one-half of one per cent by weight of water charged with the glue, and computed in the same ways as for the chloride solution.

(f) It is usual, on account of impurities in the glue, to discount these by putting in an excess, say where 100 pounds of tannin is called for, use 110 pounds of glue. While it is understood that the glue and the tannin combine in about equal quanti-

ties, yet it is safe to have a slight excess of the former, for the reason that if glue should be entirely or even partially absent there would be no action by the tannin, and it would go back into the solution tub as strong as before used. In any case, if sufficient glue is not present, full action of the tannin cannot be expected.

To determine the relative value of glues offered for use in the Wellhouse or Zinc Tannin process:

(g) First prepare a four per cent solution of hemlock extract of known strength (25 per cent to 27 per cent), by putting one ounce of extract into twelve ounces of pure water. Then treat one ounce of the prepared glue, making this also four per cent strong. The glue and water being brought to near a boil, say 175 to 180 degrees Fah.

Take seven test tubes $\frac{5}{8}$ inch by 6 inches, placed in a rack for convenience in filling and for observation. Then with a 25 c. cm. measuring tube, put into the right-hand tube seven c. cm. of the glue solution; into the second, eight c. cm., and so on until they are all served. Then take the tannin solution in the same way and like quantities, except that the left-hand tube is to receive the c. cm. of the tannin, and so on, increasing toward the right. Thus it will be seen that the fourth tube will have the same quantity of each, the glue and the tannin, and those on each hand having varying proportions. The solution should be freshly made and used while quite warm and each tube well shaken when adding the tannin to the glue in the tubes. Ordinarily it is desirable that the glue be such as will combine with an equal quantity of the tannin. Let the set of tubes stand in any safe place for an hour or two and the result in the tubes will be manifest to the observer, and the lesson easily understood.

GELATINE.

(Extract from letter of G. M. Hyams, chemist, to Chas. Dyer, July 7, 1889. relative to the use of glue in timber treating.)

In regard to the preserving process, from my own experiments and analyses, I have become convinced that the quantity of organic acids in the pine wood of our western (Southwestern) country has been much overestimated. Now it is to be neutralized; these acids that some albumenoid substance, such as glue, has to be added to the timber before injecting chloride of zinc. But as this glue, if left in the pores of the timber, would itself decay, it in turn has to be neutralized, and for this purpose tannin is added. If now we can lessen the quantity of glue to be added, we also decrease the amount of tannin to be used, and this makes a double saving.

In order to find out the minimum quantity of glue necessary, I have saturated timber in small pieces with glue and then determined by appropriate methods the excess from my results. I find that the quantity is only about one-fourth that ordinarily recommended. The most important fact, however, of this branch of the subject is the quality of the glue used, as we are seeking here the soluble albuminoid principle for a chemical reaction, namely, the coagulation of the vegetable acids of the wood. We must seek for a different test in our glue than merely adhesion (adhesiveness). To illustrate my meaning—in pieces from the same stick of timber I have used the following quantities for the same size:

Glue costing 5c. 8c. 12c 17c blood alb. pure alb.
Took..... 15 grs. 11 grs. 4 grs. 1.6 grs. 1.1 grs. 0.8 gr.

You will then readily see that, provided an easily soluble glue costing 17 cents is used, it is really much cheaper than a 5-cent article, which would not be the case if we looked to its adhesive qualities only.

So-called liquid glue is a good illustration also. I believe you have tried this and found it not to be economical. The reason is simply that to render it soluble and liquid, it has to be treated chemically in a way which destroys the neutralizing qualities of the albumen and practically unfits it for our pur-

pose. I am quite sure (confident) that with the right kind of glue a saving of 20 per cent can be accomplished.

PENETRATION OF GLUE.

The tannin and glue chiefly goes into the ends. At the Chicago works the absorption of each varies from 0.017 to 0.034 cubic feet per tie, or 1 to 2 lts. per tie (lit. eq. .035 cu. ft.), so that the solution injected would be 100 times enough to cover the whole surface 1-32 inch thick. But when the water evaporates we have left only the percentage of leatheroid, say 1 to 2 per cent, which would cover surface 1-32 to 2-32 inch.

Chicago, Dec. 3, 1900.

O. CHANUTE.

TANNIN EXTRACT.

Sec. 18. The tannin extract of hemlock bark is mostly used in this process, containing from 15 to 30 per cent of tannic acid, presumably about a safe mean of 22 per cent.

(a) As the amount of active properties in the combination, both as to the glue and the tannin, long practice has taught that they should be used in about equal quantities. As the glue is first absorbed, and the tannin following neutralizes so much of the glue as it may reach, the overplus of the tannin being carried back with the returned solution, there is no waste by having the tannin solution markedly stronger than the prescribed one-half of one per cent. The strength of the tub solution of tannin should be tested from time to time by comparison of its action on a reagent, as will be explained later on.

(b) As regards the penetration of the tannin into the timber, although the tannin solution is complete, that is, the acid is held in complete suspension and will go wherever the water will go, yet its action is and must be largely superficial from the fact that it has no such aid or favorable conditions

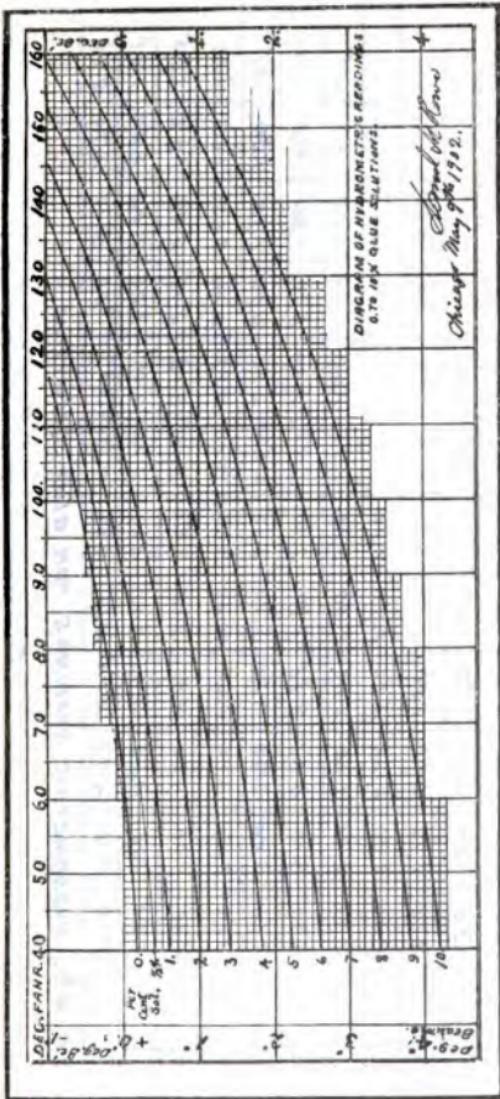


FIG. 35—GLUE DIAGRAM.

This table and diagram is useful where vat contains glue of unknown strength and is only approximately correct.

STR. 50	TEMP F.	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°
14.90	•	140	1.32	1.21	1.10	.98	.79	60	.36	.18				
1.	•	150	1.52	1.42	1.32	1.21	1.00	.78	.46	.20				
2.	•	2.00	1.93	1.82	1.70	1.55	1.35	1.15	.90	.64	.32			
3.	•	2.40	2.30	2.20	2.05	1.90	1.70	1.50	1.25	.96	.65	.24		
4.	•	2.80	2.70	2.60	2.48	2.30	2.10	1.98	1.60	1.32	1.00	.60	.15	
5.	•	3.20	3.10	3.00	2.88	2.70	2.50	2.35	2.00	1.70	1.34	.95	.48	
6.	•	3.60	3.50	3.40	3.25	3.05	2.85	2.62	2.35	2.05	1.70	1.30	.65	.35
7.	•	4.00	3.90	3.80	3.62	3.45	3.22	3.00	2.72	2.40	2.05	1.65	1.20	.70
8.	•	4.40	4.30	4.20	4.02	3.85	3.62	3.40	3.10	2.78	2.42	2.02	1.55	1.05
9.	•	4.80	4.70	4.58	4.42	4.25	4.02	3.78	3.50	3.26	2.80	2.40	1.95	1.45
10.	•	5.20	5.10	4.98	4.80	4.60	4.36	4.12	3.82	3.50	3.15	2.74	2.28	1.80

TABLE A2. HYDROMETRIC READINGS FOR GLUE SOLUTION

Chicago, Aug. 10th 1903.

FIG. 36—HYDROMETRIC READING FOR GLUE.

as does the chloride solution. That there is a portion of the glue not reached by it is a matter of speculation, and it is probable that owing to the viscosity of the glue its action is also largely superficial as well. Be this true, it is what it should be.

(c) The hemlock bark extract carrying the tannic acid is of a reddish brown color, hard when cold, but when under temperature of 100 degrees Fah. or over is the consistency of thin molasses and flows freely.

Its specific gravity is about 1.22, but when a half of one per cent solution, there is no appreciable excess over pure water.

(d) The commercial extract is put into barrels holding about five hundred pounds and over, four or five barrels usually making a batch.

To thoroughly dissolve, a quantity of water is added and a moderate amount of steam is turned in by means of a small steam pipe in the tub, by which the extract is thoroughly agitated and moderately heated, after which additional water can be added, so that some fixed depth from the mixing tub will equal the quantity of tannin needed for each tub foot in the tannin solution tub.

(e) When tannin and glue are combined the mixture, after time is given for the combination of the two, and all unassimilated portions are washed out, and the residuum dried, gives a dark-brown, semi-transparent substance that is quite hard and brittle. It is insolvent in water and incombustible, simply charring to a cinder much as would be with charred leather. Under the microscope it has the appearance of an opaque resin, and a similar substance by appearance is found in the sap cells of the treated timber, not in untreated timber.

Sec. 19. Alkaline waters usually found in the western plains and mountains is, while undesirable, yet not unusable, as while the effect is to some extent deleterious, yet not to the extent that would forbid its use. One of the effects is its liability to combine with the zinc chloride, by which a fraction

of the zinc is thrown down, reducing its effectiveness to the extent of such combination.

Another effect of the alkaline water is to affect the specific gravity for which allowance must be made, the amount to be determined by a comparison with distilled water at 60 degrees Fah. and subtracting the difference from the hydrometric reading in testing tub solution.

CHARACTER OF THE WORK AND APPLIANCES.

Sec. 20. The business of timber treating is not new, neither has it been successfully employed in all cases. It has had to pass through the various stages of development like the manufacture of steel, Portland cement and other lines of manufacture, with its modicum of failures and successes. Now, when success is to some extent attained, it is believed that the exercise of knowledge and intelligence is the only means by which recurrent failure will be avoided. This fact cannot be too deeply impressed; also that a thorough knowledge of the practical part of the business, the movements of the process and the nature of the agent used, and a thorough training in the practical handling of the works are absolutely necessary to good results. In the operator, to all this must be added a determined purpose to enforce all rules and requirements, otherwise *failure will be almost sure and very expensive.*

Sec. 21. To give the operator a fair show to carry the work properly, his convenience and the efficiency of his force, as well as the economical operation of the work, must be considered and carefully provided for.

Every part of the works should be easy of access and compactly arranged so as to be under the eye and hand of the operator.

Every part should be substantially built so that repairs will be infrequent.

Ample store houses and storage for all material

and stock to be used, as well as a good stock on hand, should be provided.

Each machine, pump, engine, boiler, should be selected to perform the kind and quantity of work that is expected from it, as the failure of any one to perform its functions promptly and properly entails a loss of time for the plant and its whole force. Where so much capital is involved, it is worth while to attend to these considerations at the start.

INSTALLATION.

Sec. 22. When the retort and all the machinery are in place and the works generally in condition to commence operation, the following preparatory steps are necessary to prevent confusion and to secure the data that is necessary for future computations and operation.

All tanks, reservoirs, tubs and vats should be filled with water so as to cause the wood to swell to tightness; the steam pipes, with steam and all other pipes, including the retort, with water, so that all leakage can be discovered and cured and that everything be permanently and reliably tight, 150 lbs. cold water pressure to be put on as final test.

The pumps and machinery should be connected and steam put on and everything tested as to its running promptly and in good order.

The retort door should be carefully adjusted so that the gland will correspond exactly with the packing groove in the retort flange and the door swing freely and truly on its hinges; that the locking levers radiate truly from the center and that the "Y" bolts be well adjusted, so that, in closing the door, all the levers will come to bearing at the same time.

VOLUME OF RETORT.

Sec. 23. In computing the amount of absorption, the amount of timber, etc., in volume, it is necessary to know exactly how much the retort holds.

Close the retort, note the indicator reading on

the solution tub, then open the main valve and entirely fill the retort with the water, again reading the indicator, and the vertical feet used by the area of the tub will be the volume of the retort. It would be well to include such number of tram cars as are used in a charge of ties, as this will be used in case of ties at all times. This, if carefully done, is more exact than any computation that could be made.

PREPARING THE CHEMICALS.

Sec. 24. Before proceeding to start the works, each of the chemicals must be prepared in such quantities as will keep on hand a stock sufficient to prevent delay in the work. Each solution tub should be filled to near its full capacity with a solution of proper strength, ready for instant use. For this part of the work a carefully instructed assistant should be employed and held responsible for the proper handling and mixing, and also that sufficient stock is held ready for use.

CHLORIDE OF ZINC.

Sec. 25. The preparation of the stock solution and its dilution in the solution tub is fully treated in sections 17 and 19, so that it is only necessary here to notice the method by which the stock of solution is kept up, both in quantity and strength, by more or less frequent renewals. If three retorts are supplied from a 30-foot tub there will be required something like ten tub feet daily, hence this many tub feet should be supplied each day. This operation consists of pumping so many feet of water into the tub and immediately adding the required quantity of the chloride as indicated in Figures 30 and 31, multiplying this by the number of tub feet put up.

For example, suppose that 8½ tub feet is wanted and the water has been put up, the strength to be 2½ per cent and the stock solution is 40 per cent strong. We see by table "B" that it requires 30.173 cubic feet of stock solution to bring each tub foot

up to $2\frac{1}{2}$ per cent, then $8\frac{1}{2} \times 30.173$ equal 256.47 cubic feet of stock solution. Divide this by area of storage vat (96 sq. ft.) will give 2.67 vertical feet of the 40 per cent chloride to be put up.

Sec. 26. If more than three retorts are operated, an additional storage vat or a larger one will be necessary, as the above indicates very nearly the capacity of one of the size indicated, and another solution tub will be necessary.

Sec. 27. As before indicated, the solution should be tested by means of the fine Beaumé hydrometer to check the strength, and should it, after being well agitated, be found too strong or too weak, then addition of water in the former or chloride in the latter case is required, the amount of each to be computed as before. The deficit in either case will be proportional as the per cent. Table "B" contains quantities for an error of one-quarter of one per cent, which saves trouble sometimes, and is near enough for most cases.

Sec. 28. The matter of monthly stock will be now noticed as the same computation comes in here. At the starting of the works, or at the beginning of each month, there is a certain amount of stock in the ware house and perhaps more arriving. To keep a proper account it is necessary to know how much stock has been used in the month, or perhaps in a separate lot of timber, hence the stock account should show just how much is on hand at any moment. This will consist of stock in warehouse, stock in dissolving vats, in storage vat and also in the solution tub, and, knowing the strength of each, the whole can be summed up as if it was still in the original package.

The simple rule for solution anywhere near two per cent will be to call each cubic foot equal to 63.4 lbs. Multiplying this by the total number of cubic feet in the tub and again by the hydrometric strength, will give the number of pounds pure chloride in the solution tub. For mixing and storage vats use table "B."

GELATINE.

Sec. 29. Resuming the consideration of glue from Sec. 17, we will take up its preparation with reference to its immediate use at the works. Glue comes to the works in barrels of 250 lbs. or thereabout, and is dissolved in a small tank or dissolving tub into which some water has been put. The packages first being weighed, then broken, and after turning the glue into the tub the empty barrel is weighed and the net amount of glue noted.

Four or five barrels can be used at one time, filling the tub with water, so that the glue be well covered and left to soak for as long a time as the exigencies of the work will allow; preferably 24 hours. A little steam is then applied so as to render the glue homogeneous, adding further amount of water to bring up the volume so that some fixed measure will indicate how much to throw up for each tub foot of the solution.

If a tub foot contains 664 cubic feet of chloride solution, the weight of which is 63.4 lbs., then there will be a total weight of 42,098 lbs., of which one-half of one per cent would be 210.5 lbs. of glue required for each tub foot. But remembering that in Sec. 17 ten per cent is to be added, brings the amount per tub foot to 230 lbs.

Dividing the amount of glue put into the dissolving tub by 230 lbs., will give the number of tub feet that it will supply with the required per cent.

The strength of the glue, whether mixed with the chloride or used separately, is supposed to remain constant, only needing new supply in proportion to the water added in keeping up the stock of solution.

TANNIN.

Sec. 30. The tannin being applied separately and being the last application is prepared in its separate mixing tub or vat and used from there by means of the same ejector as the glue, diluting it in the tannin solution tub in like manner to the glue.

The tannin solution is absorbed to a very much less degree than the chloride (usually only about one-tenth in volume), owing to the timber having already been well impregnated and to the less favorable condition for absorption. The tannin solution actually loses much more of its tannic acid than is contained in the amount of absorption of the charge, it being remembered that some twenty times the amount absorbed has been in contact with the charge with its quota of glue, and therefore is depleted to the extent of the tannin needed to neutralize the glue, therefore the following: Rule for keeping up the strength of the tannic solution:

"To the amount in volume absorbed add the amount of chloride solution absorbed; to the sum of these add tannin equal to one-half of one per cent in weight of tannin extract."

COMPUTATIONS.

DURING OPERATIONS.

Sec. 31. During the operations of the works it is necessary to know how much timber there is in the charge, how much of each solution has gone into it, etc., so as to be able to know that the work is being properly done and that accurate accounts may be kept of the amount of chemicals used. To do this, the volume of the retort should be accurately taken as before noticed. (Sec. 23), and the various solution tubs should be provided with accurate gauges, by means of which the operator can note the amount in the tub before starting, at various periods between and at the close of the operation.

These gauges should consist of a graduated board divided into feet and tenths, a good float on the solution in the tub and an indicator weight or pointer working freely by means of a cord up and down the graduated face of the indicator board. This indicator should be placed where it will be in plain sight of the operator and should be lighted at night so as to be easily read.

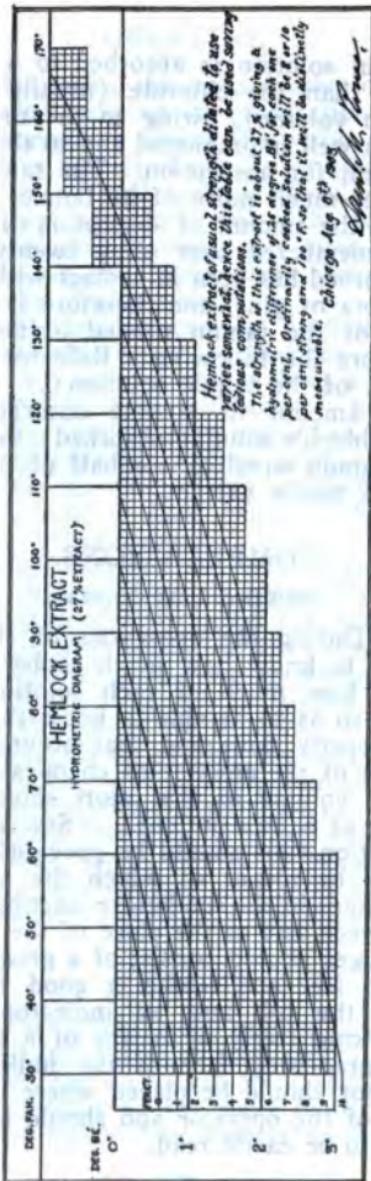


FIG. 37—TANNIN DIAGRAM.

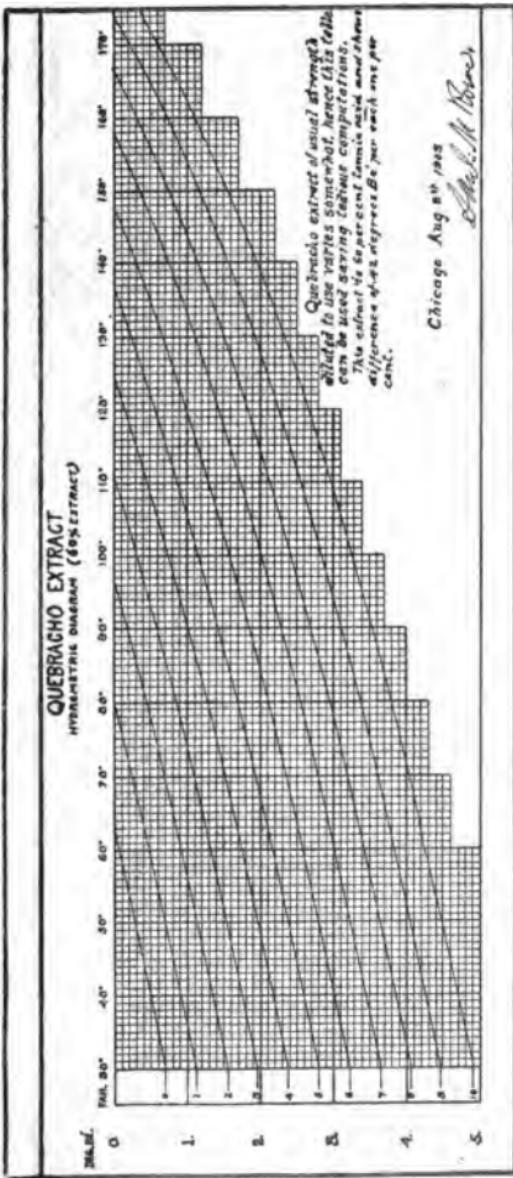


FIG. 46—QUEBRACHO EXTRACT DIAGRAM.

Only useful for stock solution.

This is a gum from a South American tree, high in tannic acid (60% and over), which requires a much higher heat to bring it into action than is necessary with hemlock or oak. With the improved heating coil there seems to be no reason why it should not come into use in timber preserving.

STRENGTH	TANNIN	50°	40°	30°	20°	10°	0°	90°	100°	110°	120°	130°	140°	150°	160°	170°
1 " Deep	.87	.65	.45	.25	.01											
2 " "	1.10	.90	.70	.50	.26	.03										
3 " "	1.35	1.15	.95	.75	.51	.27	.03									
4 " "	1.60	1.40	1.20	1.00	.76	.52	.28	.00								
5 " "	1.85	1.65	1.45	1.25	1.01	.77	.53	.25	.00							
6 " "	2.10	1.90	1.70	1.50	1.26	1.02	.78	.50	.22	.00						
7 " "	2.35	2.15	1.95	1.75	1.51	1.27	1.03	.75	.47	.16	.00					
8 " "	2.60	2.40	2.20	2.00	1.76	1.52	1.28	1.00	.72	.41	.00					
9 " "	2.85	2.65	2.45	2.25	2.01	1.77	1.53	1.25	.97	.66	.33	.03				
10 " "	3.10	2.90	2.70	2.50	2.26	2.02	1.78	1.50	1.22	.91	.58	.22	.00			

TABLE A2. HYDROMETRIC READINGS FOR TANNIN EXTRACT. (HEMLOCK.)

Chicago Aug. 10th 1903
John C. H. House,

FIG. 47—HYDROMETRIC READING FOR TANNIN.

FIG. 48—HYDROMETRIC READING FOR QUEBRACHO EXTRACT.

TABLE A² HYDROMETRIC READINGS FOR QUEBRACHO EXTRACT
Chicago, Aug. 10th, 1903.

SPEC. GRAV.	TEMPERATURE	50°	40°	30°	20°	10°	50°	30°	20°	10°	50°	30°	20°	10°	50°	30°	20°	10°	50°	30°	20°	10°
1.96	-	1.12	.92	.72	.49	.25	.02															
2.	-	1.54	1.34	1.14	.91	.67	.44	.18														
3.	-	1.96	1.56	1.33	1.09	.86	.60	.33	.02													
4.	-	2.38	2.18	1.95	1.75	1.51	1.29	1.02	.75	.46	.15											
5.	-	2.60	2.40	2.17	1.93	1.70	1.44	1.17	.88	.57	.23											
6.	-	3.28	3.02	2.72	2.59	2.36	2.12	1.86	1.59	1.30	.99	.65	.30									
7.	-	3.64	3.44	3.24	3.01	2.77	2.54	2.28	2.01	1.72	1.41	1.07	.72	.33								
8.	-	4.06	3.96	3.66	3.48	3.19	2.96	2.70	2.43	2.14	1.83	1.49	1.14	.76	.34							
9.	-	4.49	4.28	4.07	3.85	3.61	3.38	3.12	2.85	2.56	2.25	1.91	1.56	1.17	.74	.34						
10.	-	4.90	4.70	4.50	4.27	4.03	3.80	3.54	3.27	2.98	2.67	2.38	1.98	1.59	1.16	.66						

VOLUME OF TIMBER.

Sec. 32. To compute the volume of the timber in the charge: Take the lowest reading of the chloride indicator from the reading after the solution is fully forced back. This difference is the number of tub feet that was in the retort after absorption is completed, hence, when reduced to cubic feet, will be the number of cubic feet outside the charge, and taking this from the known volume of the retort, the remainder will be the volume of the charge in cubic feet of timber

ABSORPTION OF CHLORIDE, TANNIN OR GLUE.

Sec. 33. Take the indicator reading after completing forcing back from the reading at commencing, the remainder will be the tub feet of solution absorbed. Reduce this to cubic feet, multiply it by 63.4 lbs. (close approximate weight per cubic foot), which gives the number of pounds solution absorbed by the charge. Then again to determine the number of pounds pure chloride, multiply this by the per cent of strength of the solution (hydrometric, say .02 or .025, as the case may be), the product is the number of pounds pure chloride absorbed by the charge.

Then, again, divide this by the total number of cubic feet in the charge as before found, and the result will be the pounds or fraction of a pound of pure chloride per cubic foot of timber.

The same rule applies to absorption of tannin and also glue where it is applied separately from the chloride, only different in the last multiplier, which is .005 or one-half of one per cent.

ABSORPTION BY VOLUME.

Sec. 34. A very useful and instructive test of timber as to its adaptability to receive treatment is determined by its ability to absorb the solution. This

OPERATOR'S REPORT

OUR No. - - - - -	
RENTAL No. - - - - -	
COMBINED STEAMING	
50 LBS. PRESSURE INDICATED	
STEAM BLOWN OFF	
VACUUM DECREASED	
SECOND VACUUM INDICATED	
INDICATOR CHLORINE TANK	
CHLORINE INTRODUCED	
100 LBS. PRESSURE INDICATED	
LOWEST POINT TANK INDICATOR	
STARTED FINGER BACK	
COMPLETED FINGER BACK	
INDICATOR CHLORINE TANK	
IMMOBILIZED TANNIN TANK	
INTRODUCED TANNIN	
100 LBS. PRESSURE INDICATED	
COMBINED FINGERS BACK	
INDICATOR TANNIN TANK	
NUMBER OF TIES IN RUM	
CUBIC FEET TIMBER IN RUM	
ABSORPTION OF CHLORINE SOL. 20% IN VOLUME	
STRENGTH OF CHLORINE SOL. PER CT.	
Absorption of Pure Chlorine to Co. Pt. Thick. in lbs.	
TIME	
	CHARGES WERE STEAMED
	CHARGES WERE IN 20% SOLUTION
	CHARGES WERE IN TANNIN
	COMBINED IN RUM
	DESCRIPTION OF TIMBER, ETC.
	CONTENTS OF TIMBER

Date - - - - - / / /

Thermometer (Fah.) - - - - - Deg.

Hydrometer (Specific) - - - - - Deg.

OPERATOR

FIG. 39—OPERATOR'S REPORT.

is found by dividing the number of cubic feet of solution absorbed by the number of cubic feet of timber in the charge.

RECORD OF ROUTINE WORK.

Sec. 35. To have a complete record of the operation a blank form should be provided for the operator to record every move, the directing column being printed on the right hand with any convenient number of columns in blank arranged to the left, say six for the proper entries in ink, each blank column to receive the record of one run.

The items to be entered are as follows: Run Number; Retort Number; Commenced steaming; Twenty pounds indicated (time); Blow off (time); Commence vacuum (time); Twenty-five inches indicated (time); Indicator chloride tank (feet and tenths); Chloride introduced (time); 100 lbs. pressure indicated (time); Lowest point indicator (feet and tenths); Started forcing back (time); Completed forcing back (time); Indicator chloride tank (feet and tenths); Indicator glue tank (feet and tenths); Introduce glue (time); Force back glue (time); Indicator glue tank (feet and tenths); Indicator tannin tank (feet and tenths); Introduce tannin (time); Force back tannin (time); Indicator tannin (feet and tenths).

Number of ties; Cubic feet of timber in run (computed); Absorption of chloride in vol. per cent (computed); Strength of chloride solution (per cent hydrometric); Absorption pure chloride to cubic foot of timber in lbs. Time consumed in run (hours); time consumed in shift; kind of timber treated.

On left of last column should be date, temperature of solution when tested, hydrometric reading and signature of operator.

With such a report filled out for each and every run, departure from the prescribed routine cannot be concealed, but will be apparent.

While the requirements above say feet and tenths,

it is possible with care to read the indicator to hundredths of a foot, and this should be done.

MEASURING SAPS EXTRACTED.

Sec. 36. Recurring to the practicability of measuring or determining the actual amount of saps extracted from the timber with any degree of accuracy is doubted. It is found that very dry timber, after being steamed, is invariably heavier if withdrawn at end of the vacuum than when introduced, showing that the timber has absorbed a greater amount of moisture than replaces the saps extracted. On the other hand, very green or water-logged timber will be markedly lighter, the only conclusion we can draw is that more moisture has been withdrawn than went in in the form of condensed steam, but how much sap came out or how much condensed steam passed in and remains in the timber is impossible to tell. The fact of the matter is that during the process of steaming large amounts of the saps are blown out with the condensed steam in keeping the retort clear of condensations, the quantity being of such amount as to load the out-flowing water highly with the juices of the timber. This is entirely outside of that collected by the hot well, and of much greater volume.

KIND OF TIMBER AND CONDITION.

Sec. 37. The soft and open grained timbers, such as the southern lowland pine and the mountain pines of the west, have been submitted to treatment with a high degree of success. The life of these pines are, when laid without treatment, from three to four and one-half years when cut from young growing timber in the form of pole ties. Later, hemlock, tamarack and even cottonwood have been used with good result, the life when treated by the Wellhouse process being prolonged very much. While sufficient record as to the relative life

TIMBER TREATING PLANT.
MONTHLY REPORT OF TIE AND TIMBER TREATING.

Month Ending..... 10....

NUMBER OF RINGS MADE		TOTAL NUMBER OF TIES TREATED	
"	" TIES TREATED, SAWED X INCHES X FEET		
"	" HEWN X INCHES X FEET		
"	" HEWN		
FEET B. M. TIMBER TREATED INCLUDING SWINN TIES			
LINEAL FEET PILING TREATED			
TOTAL NUMBER CUBIC FEET TIMBER AND PILING TREATED			
TOTAL OUTPUT REMOVED TO HEWN TIE @ 4 CUBE FEET EACH			
 COST OF TREATMENT.			
Chemicals		Doll.	Cts.
Zinc	lbs @ cts - \$		
Gelatin	lbs @ cts - \$		
Tannin	lbs @ cts - \$		
 Labor		Doll.	Cts.
Fuel and Supplies			
Coal	tons @ \$		
Freight	cords @ \$		
Oil and Supplies			
 SWINNERS AND OTHER MISCELLANEOUS EXPENSES		TOTAL COST OF TREATMENT	
 COST PER TIE.			
Chemicals		Doll.	Cts.
Labor		Doll.	Cts.
Fuel		Doll.	Cts.
SWINNERS, SUPPLIES & MISCELLANEOUS		Doll.	Cts.
AVERAGE COST PER TIE			
AVERAGE ABSORPTION OF ZINC OXIDE IN LBS. PER CUBE FOOT			
"	" GELATINE PER TIE LBS.		
"	" TANNIN PER TIE LBS.		
PRODUCTION FOR MONTH STAMPED			
AVERAGE TIME CHARGE WORK STRIPPED			
"	" IN Zinc TREATMENT		
"	" GELATINE "		
"	" TANNIN "		
ESTIMATED TIME TIMBER WAS OFF BEFORE TREATING			
WAS PROPORTION OF REUT WOOD OR GREEN OVER OR UNDER AVERAGE			
NOTE BELOW ANYTHING SPECIAL IN REGARD TO CHARACTER OF TREATMENT OR IN THE METHODS USED DURING MONTH			
WAS LUMBER AND TIES GREEN OR GENERALLY WELL DRIED. ALSO ANY VARIATION FROM USUAL METHODS AS TO PRESSURE TANNIN OR NUMBER OF SOLUTIONS.			

Signed.....
 Superintendent.....

FIG. 40—MONTHLY REPORT.

in each case has not been kept, yet it is presumed that it would be found to be at least double, some estimating it at three times.

In the case of heart timber that is sound and well matured the life can be safely placed at 50 per cent higher, as heart timber is more lasting on account of its maturity and firmness of fiber and greater freedom from fermenting juices.

While it is true that sap and open grained timber will absorb more of the antiseptic solution than well-matured heart timber, and is, by some, considered most suitable for treatment, yet it is not clear that the very best timber cannot be treated with equal profit.

The fact probably is, that any timber, not excluding the best white or bur oak, will be benefited to such extent as to be profitable and advantageous by the prolongation of its usefulness.

That a compact timber will not absorb as large amount of the preservative is owing to the large amount of solid wood fiber and the smaller per cent of voids in the timber, which only serve for the lodgment of the preservative, hence this should be no reason for barring it out, but, on the contrary, should be in its favor.

The available voids in timber varies from 20 per cent in volume for compact heart timber to over 60 per cent for Texas short leaf pine. The compact timber is not confined to the oak, hickory, etc., but will be found among the pines. In almost all cases the best timber is found in the lower part or butt cut of the tree.

All in all, it is true that the better the timber the better the tie, whether treated or otherwise, in spite of its inability to absorb so much of the antiseptic.

SEASONING.

Sec. 38. To secure the best possible results, any timber should have such an amount of seasoning as will free it largely of the green saps existing in the

live tree when cut, or to such extent as may be practicable by exposure to a dry atmosphere for perhaps from 60 to 90 days; more time in a damp, rainy climate than in a dry, sunshiny exposure.

Practically speaking, the determination of condition of timber suitable must be largely a matter of judgment with the further aid of actual results when put through the process.

If perforce timber is treated while in a water-logged or green, freshly cut condition, then special means must be resorted to, prolongation of steaming, interposition of extra vacuum, prolongation of pressure on solution, or all of these, but as a rule this should not be done if possible to avoid it, as the results will be uncertain.

Kiln drying is recommended by some, but this adds too much to the expense and cannot be as good in any case as Nature's action with time.

STORAGE OF TIES IN STORAGE YARD.

Where it is desired to give a season of drying to incoming ties, a method of piling is advised where the air has fair access to most of the surface of the ties. In practice a course of four alternating with a cross course of seven in the case of average hewn ties will do this fairly well. Ties so cribbed in a dry climate have been known to lose the greater part of their water in one month.

STORAGE ROOM.

It is found that if storage tracks are spaced 64 feet center to center six cribs can be piled, still leaving ample clearance for use of tracks by passing cars.

UNLOADING AND PILING.

Where taken from cars the piles can be made as high as the top of the cars, say 12 feet, and if piled as before stated there will be six piles of 110 ties

each every 10 feet of the space between tracks. At this rate the space required per tie would be one square foot of ground in the storage part of the yard. Hence, a yard 1,500 feet long and 350 feet wide would store 525,000 ties. If the ties to be stored are sawed ties, the amount that could be stored would be 25 to 33 per cent greater.

Sec. 39. Live and growing timber with its natural saps and its sap cells in their normal condition will resist the introduction of any fluid, much on the principle that two bodies cannot occupy the same space at the same time. To be able to introduce any solution, the natural saps of the timber must be in some way freed and expelled from the timber either by being evaporated by drying or must be forced out by heating, loosening and expanding into vapor, as is done under the steaming process. The saps in freshly cut timber will immediately begin to evaporate when, under favorable conditions, the timber is exposed to the air, the action commencing on the exposed surface and gradually advancing toward the center of the piece, but if, on the contrary, it is exposed to much dampness and high climatic temperature, the evaporation progresses very slowly and the fermentation of the juices of the timber will act quickly, forming at once the basis of active decay. The time required to dry the timber by exposure to the atmosphere alone will go far toward its destruction, the fermentation of the saps forming the fungi of decay, attacking the delicate cells and more delicate and less compact portions of the timber and then the firmer portions, until, in a few months, the timber becomes spongy throughout. Timber that has reached this stage will take the solution freely, but if decay has gone so far as to allow excessive absorption, it will be of little value even if treated.

Sec. 40. Under the action of steam in the retort, the juices are heated to such temperature as will expel them rapidly, arresting any incipient decay and destroying the delicate mechanism of the sap

cells, clearing the way for the ingress of the solution. Microscopic examination proves this to be true.

It is, therefore, important that the time the steam is held must be adjusted to the condition of the timber, the most important consideration being that its action shall reach the center of the piece.

The rule here adopted is for 20 lbs. pressure, which is equal to 250 degrees Fah., which is the highest degree of heat allowable to which the timber can be subjected without injury. The steam used should be saturated steam, as with superheated steam the temperature is uncertain, while no special advantage is gained.

PENETRATION OF STEAM.

To determine when the penetration of steam during the steaming process has reached the center of the piece, the following is proposed: Fix a connecting pipe to the lower dome, so that the condensation during the steaming can be frequently drawn, the pipe running to a sink in the machinery room, and provided with a small cock. Then at intervals of a half hour, draw from this saving a small quantity to fill a test tube. A rack holding 10 or 12 tubes will suffice for six hours' steaming. The operator will then have before him a means of judging when the off-fall of the timber juices is complete. It is not expected to thus form a definite rule, but to give a hint that may aid very much in determining when the penetration is complete.

The different timbers, of course, give different appearances in the off-fall, hence the operator has to read the signs and draw conclusions. The main point is to know when the timber is *cooked through*, as on this will depend largely the thoroughness of the penetration of the antiseptic, whether it be oil or solution.

THE ECONOMIES.

Sec. 41. The following estimate is based upon the conditions existing on the A., T. & S. F. Railroad line in New Mexico in 1885.

The prolongation of life of the Mountain Pine there used, from a mean of four and one-half years to about twelve years, is quite well authenticated. On this is based the following estimate:

For a period of twelve years.

Untreated tie placed 2 2-3d times

Cost of tie, 35c. x 2 2-3 times.....\$0.93

Cost of placing in track, 2 2-3d ts. .40-\$1.33

Treated tie, one, 35c.....\$0.35

Cost of treating, 15c..... .15

Cost of placing, 15c..... .15-\$0.65

Making a saving in twelve years of 68 cents per tie or five and two-thirds cents per tie per annum.

To more fully appreciate what this means, multiply this by 2640 ties in each mile you have \$149.50, or approximately \$150 per mile per annum. As the works built in 1885 consisted of two retorts, with annual capacity of 400,000 ties, sufficient to renew 300 ties per mile on 1,333 miles, the annual saving on this basis would be something like \$200,000.

The Las Vegas Works cost about \$30,000, a small part of the annual saving (about 15 per cent).

GENERAL OBSERVATIONS.

Sec. 42. In a general way, the true value of the results must be deducted from the mass of and not from individual cases or of a few specimen pieces.

The variations in density and other conditions are as various as there are varieties of timber or parts in the tree. Then again, even with the most careful inspection timber more or less unsound will come with the rest, to disturb the investigator should he resort entirely to chemical analysis on which to found an opinion as to the thoroughness of the treatment or the value of the results.

Speaking from a practical point of view, the following line of reasoning will apply: The agents used are commercial commodities used in gross amounts as salt is used to preserve meat, a small

variation cutting a figure only where large quantities are used, where system will conserve economy, but where no slight variation will affect the efficiency of the treatment. In this the chemist can guard against the purchase of adulterated stock.

Again, the rules and methods for the zinc-tannin and kindred processes are so well defined that the operator, with the exercise of good judgment, can get almost any desired result, and will know just what he is doing as to amount of absorption. He will know that when he puts in a tie weighing 100 lbs. and it comes out weighing 175 lbs. that it has absorbed 75 lbs., no more, no less, and knowing the strength of the solution, he can safely say that it has just so much pure chemical agent, whatever it may be in it. To determine how much has been absorbed by any or every particular piece in the charge is manifestly impracticable, hence only the gross result is manifest at the time.

It must be remembered that each of the different processes have been carried on for years, and their effectiveness and value are no longer in the field of theory, the proofs of effectiveness having been secured after the lapse of sufficient time to amount to a demonstration. The chemist may find a tie that has been in service 15 or more years that has but a trace of the chemical, and he may find one of the same timber that has failed at less than five years, both having been treated in the same charge, yet for reasons before given this proves nothing as to the real value of the process or of its failure.

The operator that is armed with a thorough knowledge of chemistry has something that will be of great aid to him, but he will find it of much more importance to study the mechanical and physical features of his work, for instance, whether his steam reaches the center of a tie, what the best temperature for his solution, how various timbers are best rendered penetrable, and a hundred other matters vital to the success of the process.

CAUTIONARY.

Sec. 43. In conclusion, and at the risk of repetition, the operator is reminded that it is of the utmost importance that every part of the work is carried out according to the rules laid down, that the condition of the timber be carefully studied and the best method be adopted to meet this, that every precaution be taken to detect any failure that may occur and to take the proper means to rectify this even to a repetition of the treatment, and to labor to instruct those under him in the highest possible degree to the same end.

By no other means can good results be surely obtained, and any mistakes escaping his vigilance, while not immediately apparent, will tell seriously some time in the future.

Extraneous influences will often be brought to bear to have received and treated timbers not in proper condition to be treated, but such should be received under protest if received at all, and a record should be made of these facts. In this way only will the process be protected against unfair charges of failure.

The operator probably will have little control as to timber delivered to him for treatment, but it is his duty to see that each different class or kind is treated separately as far as is possible, and to study the method of handling the process best adapted to each, bringing every check in his reach to bear, not forgetting the weighing and other means of developing the best methods.

BURNETTIZING.

For the Burnettizing process the appliances are the same as for the Zinc-Tannin except that the tubs for the glue and for the tannin can be omitted and that part of the pipings by which they connect to the retort are also omitted. The precaution is usually taken to put in connections for the piping so that in case of change to the other process, that much labor and expense is saved by so doing.

FOR CREOSOTING.

(a) The additions necessary to provide for creosoting are the necessary storage tub, which should be of metal, as well as a dumping tank in which the oil is dumped from the tank car in which it is usually shipped to the works. The capacity of the storage tub depends upon the desired capacity of the works or the portion of the works devoted to creosoting and the amount of timber that is to be treated.

(b) The same pipes are used as with the Burnett except, of course, the main pipe to the header, but these pipes through which the oil is passed must be provided with inside steam pipes by which the oil shall be kept fluid by means of live steam passing through them.

(c) In addition to this the retort must be furnished with a system of heating pipes (steam) of such heating surface as will quickly heat the oil in the retort to the desired temperature. This is done by manifold coils of iron pipes. As the oil must at all times be entirely fluid, the storage and the dumping tubs must also be provided with ample heating coils.

The absorption is secured in the same way as with the Wellhouse or the Burnett process, first by opening the pores of the wood by steaming, followed by the oil under pressure aided by a much higher temperature on the oil.

UNITS IN COMPUTATIONS.

Sec. 44. Line measure feet, tenths and hundredths, to three decimals.

Cubic measure, cubic feet and fractions to three decimals.

Tub or vat feet equal area of tub or vat x 1 foot (vert.).

Weights, lbs. Avoirdupois to one to three decimals.

Gallons U. S. equal 231 cubic ins., not used as being less convenient than cubic feet.

Weight of water at 60 deg. Fahr. equal 62.4 lbs. per cubic foot, or .5775 per oz. Av. (Sea water said to be 64.1.)

Pressure, steam and cold water is counted as per square inch in lbs. Av.

Temperature, Fahrenheit Thermometer (always). Weight of concentrated sol. zncl. See table (B) Empiric.

Per cents should be carried to three decimals.

Means by weight except where otherwise specified.

LAGGING THE RETORT.

The practice in regard to providing nonradiating covering for the retort is quite varied. There is no doubt that an economy of fuel results, but, on the other hand, experienced operators claim that there is a loss of time and more difficulty in securing a perfect vacuum, owing to the slow cooling of the retort after the steam is discharged. If the retort room is closed, the temperature gets very high so that the radiation is not very great after the heat in the retort gains the maximum and when steam is drawn, and by the same line of reasoning the retort room should be opened. This is not usually done, however, and the practicability of doing so is doubted, as usually some one of the retorts reach this stage at almost any hour of the day.

In case of the outdoor portable plant, the lagging seems advisable as the radiation is necessarily great. More light will be necessary to decide whether the additional cost of the lagging is justified in the covered works.

TEST OF STRENGTH.

ZINC CHLORIDE SOLUTION.—POWERS.

The apparatus necessary consists of a graduated glass burette and an ordinary coffee cup. The sketch shows the method of making the analysis.

A is the glass vessel containing the zinc solution diluted with distilled water containing a little potassium monochromate. B holds the standard silver nitrate which is delivered into the cup (A) by means of the pinch cock. As long as there is any free zinc chloride left in A, the solution will remain yellow from the potassium chromate, but the moment it has all reacted with the silver nitrate, one drop in excess silver nitrate solution reacts with the chromate to form a blood red solution, so if we take a definite volume of zinc chloride solution in A, and have the silver nitrate in B of the right strength all we have to do is to simply read off the number of c. c. of B solution used and we have the strength of the zinc solution direct.

A correction has to be applied in making up the strength of the silver nitrate solution because of the presence of chloride of sodium in the water used From G. W. NOYES.

The use of the metric system will only be noticed so far as is applicable to the graduated measures used in testing laboratory, the larger measures and weights usual in the metric system being less convenient for the ordinary computations of volume of tanks, retorts, volume of timber, etc., than the cubic foot (U. S.) as the unit.

The plant of the Mexican Central Ry. Co. is arranged for the metric system and the following equivalents will be convenient for converting these to cubic feet, pounds, etc.

ONE GRAMME.

1	gramme	=	15.4322	grains.
1	"	=	1 c.cm. of pure water at 39.2 deg Fahr.	
1000	"	=	2.2046 lbs. Av. (= 1 kilogramme).	
1	"	=	.0022046 lbs. and	
1	"	=	.0352736 oz. and	
1	"	=	15.4322	grains.

LINE.

1 centimeter	=	.393704	inches, =	.032809	feet.
1 decimeter	=	3.93704	" =	.328087	"
1 meter	=	39.37043	" =	3.280869	"

SQUARE.

1 square meter equals 10.763 square feet.

CUBIC.

1 cubic centimeter	=	.0610254	cubic inches.
1000	"	=	1 litre.
1 cubic meter	=	35.8105	cubic feet.

WEIGHTS.

1 kilogramme	=	2.2047	lbs. avoirdupois.
1 gramme	=	15.433	grains (1-7000 lb. av.)

EXPANSION OF FLUIDS BY HEAT.

Water expands in volume :

Per degree Fahr.,	$\frac{1}{100000}$ or .0002424	= 1.
Creosote oil,	$\frac{1}{100000}$ or .0004727	= 2.
Stock chloride of zinc, 46%,	$\frac{1}{100000}$ or .0008171	= 1.3

IMPLEMENT FOR TESTING SOLUTION.

Sec. 45. One avoirdupois scale, 4 lbs. down to grains.

One graduated glass test tube, 200 c. cm. will do, 1½ inch. dia. x 12 inch.

One 1000 c. cm. graduated glass to set on scale, with counterbalance.

Two plain test tubes, 1½x12 inch.

Two dozen test tubes, ¾x6 inch, with cork stoppers.

Two glass funnels, 3-inch dia.

One package filters, 6-inch.

Two open glass jars, 4-inch dia. and 6-inch high.

Two Beaumé hydrometers, 0 to 60 deg.

Two Beaumé hydrometers, 0 to 6 degrees, test to exactly 0 in pure water at 60 deg. Fahr. (Duplicates to meet accident).

One floating thermometer, Fahr. zero to 250 deg.

One argand lamp with stand.

Six four oz. glass beakers.

Three porcelain saucers, say 4-inch dia.

Two galvanized iron pails, 4-inch dia. and 12 inches deep, with wire bail to handle samples of solution.

A half dozen or more glass bottles holding a pint or more and having ground glass stoppers will be useful to hold various reagents used for testing the solutions, some of which are noticed below.

REAGENTS. Methyl Orange, a 1-1000 solution for testing for free acid in the chloride solution.

Ammonia for testing for iron.

Barium chloride for sulphates.

Alum and glue for tannin solution, etc.

TO TEST STRENGTH OF TUB SOLUTION OF TANNIN.

(1.) Prepare reagent as follows:

Pure water, one liter (1000 grammes).

Best glue, three grammes (50 grains approximately).

Alum (sulphate), one gramme (16 grains).

Heat to 100° Fahr. and let stand 24 hours to dissolve, then bottle.

(2.) Make up a small quantity of one-half of one per cent tannin solution as follows: Presupposing that a sample quantity of known strength in tannic acid is kept on hand, then take 12 ounces pure water, add to this 26 $\frac{1}{4}$ grains tannin extract (30 grains is close enough), warm and mix well, then filter well through two sheets of filter paper and bottle for further use.

(3.) Then take a small sample of the tub solution, filter well as with the testing solution, then take from each ten cubic centimeters and put each into a test tube by itself adding the same amount of the reagent (No. 1) to each, shake well and cork.

The glue will combine with the tannin in each, the combination settling to the bottom so that the relative amount will be apparent to the eye in two or three hours. If the tannin is all taken up, the superincumbent water will be nascent and clear of color; if not, and the amount of glue is insufficient, the water will be tinged red, and if on the other hand there is more glue than tannin, the water will be turbid and of a whitish tinge. If, however, the tannin is anything near the standard the above will do.

For the following, we are indebted to Octave Chanute, C. E.:

FOR TESTING PURITY OF ZINC CHLORIDE. (Zncl.).

For Sulphates. Taking two or three per cent solution, add a little barium chloride. If the result is a milky white precipitate it shows presence of sulphates. The precipitate is barium sulphate.

For Free Acid. To a two or three per cent solution of Zncl, add a few drops of methyl orange solution (1-1000 solution), and if the methyl orange changes color it shows presence of free acid.

To remove this, one of the most objectionable features and most easily removed, place sufficient zinc

spelter (metallic zinc) in the neutralizing vat to combine with and take up the free acid.

For the presence of iron, one of the most injurious of impurities, add ammonia, and shake well. If there is a reddish brown flocculent precipitate, it indicates the presence of iron and the precipitate is ferric hydrated iron. The presence of over one-half of one per cent, should condemn the chloride. For timber preserving even less than this sometimes considered sufficient to condemn.

VISUAL TESTS OF THE VARIOUS CHEMICALS.

Ordinarily it is difficult to obtain an operator who is sufficiently proficient in chemistry to test the various chemical agents in use and at the same time having the requisite experience in the practical part of the operation, and it is here questioned whether it is at all necessary.

With the ordinary intelligent business man visual tests easily understood and quickly applied are the most desirable.

Some of these are here given and more will be developed by intelligent operators from time to time.

VISUAL TEST OF DENSITY, STRENGTH AND PURITY OF FUSED CHLORIDE OF ZINC.

FOR DENSITY.

Put 140 cubic centimeters of pure water into a 200 c. cm. tube, equals 8.8456 cubic inches, then add two ounces of the pure chloride fresh from the drum. After the chloride is fully dissolved and the heat generated in dissolving it has been given off and the solution reduced to the original temperature (60 deg. Fahr.), then note the reading in the glass. The increase will be the volume of the fused chloride in cubic centimeters, from which the density can be calculated.

Reading equals 156 c. cm. equals 2.0483 ounces per cubic inch or 350 lbs. per cubic foot.

STRENGTH.

If the chloride is measurably pure, the total weight of the 140 c. cm. water (4.9339 oz.), plus the two ounces of fused chloride divided into the two ounces chloride will give the per cent of strength, the hydrometer reading 29 per cent while the figures will be 28.84-100 per cent.

PURITY.

If the water is pure and the chloride also, the contents of the tube will be clear as crystal, but usually it is difficult to get water entirely free from lime or other slight impurities, which will be shown in a white flocculent deposit at the bottom of the tube.

If the chloride is not pure this will show itself by letting the tube stand for a number of hours, the impurities settling to the bottom, when the proportion of impurities can be read on the graduation tube.

Some of the zinc spelter used in the manufacture of the chloride, especially the Missouri zincks, have a considerable amount of lead which produces a chloride of lead of heavier specific gravity, causing it to settle to the bottom, the line of separation being clear and distinct. Some chlorides have been found to contain near 10 per cent of this with other like impurities. Pure chloride of zinc will always remain clear and pellucid.

Example: Using 200 c. cm. graduated cylinder.

Take pure water 5.2861 ozs. (equal 150 c. cm.), add 4.3250 ozs. pure $ZnCl_2$ (fused) for a 45 per cent solution. Let it dissolve and remain in 200 c. cm. tube and observe the settling.

4.3250 ozs. at 8 c. cm. per oz. equal 34.6 c. cm.
5.2861 " " 150.0 water.

January 5 all dissolved **184.6 c. cm.**
Hyd. Be. 45 per cent.

Impurities equal 26.5 c. cm. divided by 184.6 c. cm.
equal 14.85-100 per cent.

TEST OF TANNIN AND GLUE.

The basis of such tests will be a gallon of the tannin (hemlock extract), the strength in the tannic acid being first carefully determined, say from 23 to 28 per cent usually, then for a "suitable glue."

Take 12½ ounces of the pure water and one-half ounce of the tannin, heat to 180° Fahr. and stir well.

Take the same amount of water with half ounce of the dry glue, boil until glue is thoroughly dissolved, requiring 180° Fahr. Bottle both and use before cooling. Then measure this four per cent solution into test tubes as described below, and set in warm place, say from 80° to 110° Fahr., each tube being well shaken. Set over night and combination will be complete, the condition making it manifest in which proportion it is most complete. If the combination is complete with equal parts, we have the suitable glue; on the other hand, if most complete with a less amount of tannin and a larger amount of glue, it is deemed undesirable. The value of glue for the purpose is in the amount of gelatine it contains. The higher grades lose some of the gelatine in refining.

It is probable that this same method may be found practicable in determining the approximate strength of tub solutions of either glue or tannin, as the affinity between these two chemicals is so strong that they will combine even when mixed with any amount of other impurities.

To make this test, take seven tubes, $\frac{5}{8}$ inches diameter and 6 inches long is the most convenient, setting them in a proper rack. With a 25 c. cm. graduated cylinder, measure into No. 1 at the right hand 8 c. cm. of the glue solution, nine in the second, ten in the third and so on to 14 in the seventh. Then take of the tannin solution 14 c. cm. for No. 1, 13 for No. 2 and so on reversing the quantity to that of the glue. The middle tube having equal quantity of each, the tannin will combine and throw down the glue leaving the water quite clear as long as the combination is complete and the amount of leatheroid will settle to the bottom of the tube in a quantity in proportion

to the amount of glue, gradually increasing toward the left until the quantity of glue becomes too great when the glue or the unconsumed portion of it will remain in suspension rendering the water turbid and reducing the deposit of the leatheroid.

TO DETERMINE WHEN THE TIMBER IS COOKED THROUGH.

The plant should be so constructed that the condensation during steaming can be drawn off frequently, say every thirty minutes. A small pipe leading from the blow-off to the sewer can be brought to a sink in the engine room so that a small quantity can be secured and placed in a test tube in a rack placed in the window where it is easily observed.

Usually the operator can judge very closely when the timber juices are exhausted and thus avoid wasteful continuance of the steaming. With most timbers three and a half hours is sufficient.

TO DETERMINE THE EFFECT OF STEAMING AND VACUUM.

It will aid the judgment very much by weighing a car or two in a charge before introduction, again after vacuum, and again after withdrawal at the completion of the treatment. Timber very dry on introduction will be found slightly heavier after the vacuum, but very green fresh cut timber will be found lighter, having given off more of its saps than it has absorbed of the moisture of the steam.

BURNETTIZING, CREOSOTING AND OTHER PROCESSES.

BURNETTIZING.

We think it worth while to insert a paper written by Harry Grimshaw in 1885, in full. His description of the "Burnett" process is too concise and complete; so free from technicalities, and couched in terms easily understood, and his paper is so complete—a compendium of the state of the timber preservation of that time—that it is deemed worthy of reprint here.—ED.

ON THE PRESERVATION OF TIMBER FROM DECAY.

BY HARRY GRIMSHAW, F. C. S.

The perishable nature of wood, especially when placed in situations where there is an excess of moisture in the surroundings, has led to many experiments with a view to discover a process of treating timber with salts or oils that would preserve it from decay.

Dry rot, sometimes called sap rot, the most formidable disease to which timber is subject, is commonly attributed to a combination of the acids found in the sap with the oxygen of the air, which produces fermentation, followed by decomposition. Unseasoned timber, placed in damp situations, with partial ventilation, will soon show signs of dry rot. Beams,

which presented the appearance of being sound on the outside, have been found completely rotten on the inside. The shell remains sound because it becomes seasoned and relieved from the sap.

Wet rot (as distinguished from dry rot) is considered to be occasioned by alternate exposure to moisture and dryness, beginning at the surface of the timber and working inward. Piles and other timber placed in salt or fresh water will show signs of wet rot at the water line before it attacks other parts. Posts, set in the ground, first begin to rot at the ground line.

Among the earlier investigators on the subject of preserving timber may be mentioned Johann Glau-
ber, the famous chemist of Carlstadt, Germany, who in 1657 experimented with vegetable tar and pyroligneous acid, the wood having been first carbonized by the action of fire, then covered with a coating of tar and immersed in pyroligneous acid. Since this period many processes have been tried, but most have not survived, either through cost of material or difficulties in their application. Since then, up to 1846, no less than forty-seven (47) different processes adapted for the preservation of wood are recorded, besides others of more recent date. Of these processes, many of them would, no doubt, prove effective, provided they could be carefully and economically applied. It is a difficult problem to treat timber in large quantities and meet with reasonable success. The condition of the timber that is to be treated should always be considered. It should be sound. The trees should be cut during the season when the least amount of sap is flowing, which in this country is in the winter, say from November to February. It should not be treated in a frozen state, and it is advisable to shape the timber to the form in which it is to remain before the treatment is applied.

Seasoning is a very important factor. A few months of exposure to the air and sun will materially add to the durability of the wood. The process of treatment must be rigidly and faithfully performed. The opportunities of gross frauds which cannot

readily be detected, are many, and the numerous instances on record, where cheating has been systematically carried on at works established for the purpose of treating timber, prove that the safest course for parties using preserved timber is to do the work themselves.

Three of the well-known processes for preserving timber are the following, viz.:

1. Creosoting, Creosote oil (so called) being the antiseptic.
2. Burnettizing, chloride of zinc being the antiseptic.
3. Kyanizing, corrosive sublimate being the antiseptic.

CREOSOTING.

The creosoting process consists of injecting timber with hot creosote oil, in a closed cylinder, under pressure. It was invented in 1838 by John Bethel, who found that by forcing at least seven pounds of creosote oil into each cubic foot of timber, the process was satisfactory for railroad sleepers and other railway work, but that for marine work it was better to have not less than ten pounds per cubic foot. In other countries, experimenters have used from ten to twenty pounds of creosote oil per cubic foot, and the estimated cost is from sixpence to a shilling per cubic foot, or fifty to one hundred shillings per thousand feet, board measure. Creosote oil (such as is most commonly used in this country and abroad for the treatment of wood) is distilled from coal tar. It is a heavy oil which will sink in water, and contains carbolic acid, creosote, and other constituents considered effectual for the preservation of wood. Creosoting is far from being a cheap process, and for this reason perhaps more than any other, it has failed to be extensively adopted in America. Creosoting meets with favor in England, and at the present time it is the only process that is carried on with any degree of magnitude and success.

BURNETTIZING.

Burnettizing was introduced by Sir William Burnett, in 1888. The invention consists of destroying the tendency of certain vegetable and animal substances to decay, by submitting them to the action of chloride of zinc. The degree of dilution recommended by Burnett is one part by volume to fifty parts of water. The method of impregnating the wood under a pressure of seven to eight atmospheres, as is done in the creosoting process, is most commonly used. The cost of burnettizing is less than one-third of the cost of creosoting. There are no burnettizing works of any extent in America at the present time. Some of the railroads in various parts of the country have experienced good results from the burnettizing of ties, especially ties of soft wood, such as pine, tamarack, hemlock and cedar. Among them may be mentioned the Rock Island and Pacific Railroad, the Lehigh and Susquehanna Railroad, and the Vermont Central Railroad. The process was introduced at Lowell, in 1850, and conducted faithfully for about twelve years, during which period a very large amount of timber was burnettized for bridges and other structure purposes in exposed situations.

In Germany, burnettizing meets with more favor. The Stuttgart Technical Convention of 1887 expressed itself as follows :

"As the experience of those railroads that have from twenty-five to twenty-six years impregnated their sleepers with chloride of zinc, under pressure, after steaming and abstracting the sap, has been very satisfactory, and as this system costs only one-third or less compared with impregnation with creosote or corrosive sublimate, many of the railroads have adopted the chloride of zinc process."

Steaming the wood under a pressure of sixty to seventy pounds per square inch, as done in Germany, preparatory to burnettizing, no doubt adds to its durability. Tredgold considers that steamed timber shrinks less and stands better than that which is naturally seasoned. Barlow, another good authority,

is of opinion that the seasoning goes on more rapidly after the piece is steamed.

KYANIZING.

This process was invented and introduced into England in 1832, by John Howard Kyan. It consists of steeping the wood in a solution of corrosive sublimate, and the degree of dilution is usually one pound of the salt to ninety-nine pounds of water.

It is a very slow process compared with those in which the wood is impregnated under pressure, and requires about as many days for treatment as creosotizing or burnettizing would require hours.

The usual rule in America is to allow the timber to steep in vats for a length of time, depending upon its least thickness, thus, if the timber is ten by twelve inches thick, it would remain in the vats eleven days; if six by nine inches, it would steep seven days. Bichloride of mercury, which is the antiseptic in this process, contains muriatic acid, which acts upon iron, and it is found impracticable to attempt to impregnate the wood under a pressure in iron cylinders, as can be done when creosote oil or chloride of zinc is used. Kyanizing was introduced in Woolwich by the royal engineers in 1836, but has gone out of use in England. The great cost of the material no doubt has been the chief cause of this, as a material costing 3d 6s per lb. has small chance of adoption where creosote is about 8d. per gallon, and pure chloride of zinc under 2d per pound, although in America, where these two latter named substances are not so readily obtainable, the kyanizing process of impregnation with bichloride of mercury has recently been carried on.

The only rival therefore to creosote as a preservative of timber, is the chloride of zinc, and now that the means of production of the latter have rendered it so cheap, it is becoming largely adopted on the continent, and the English railway companies, mine owners, and other users of timber should, in their own interests, study the application of this substance as

preservative from decay. At the prices ruling at the present time, the chloride of zinc process (originally denominated burnettizing) is less than one-third of that of creosoting, and in view of the fact that creosote and other heavy oils are destined to be more largely used as fuel, the economy effected by the use of the chloride of zinc will become greater.

Railway companies especially would benefit, both by the lower cost of the process and by the fact that large quantities of creosote would be released from use for timber preservation, and so be available for fuel under their locomotive boilers.

As to the cost of the process, it is found that the solution of chloride of zinc, of the right strength for preserving of timber, is of about four per cent Twaddle's hydrometer, or 1.02 specific gravity, and the price of this to-day is about seven shillings per ton. The price of creosote oil in most places will be at least two pence per gallon, which is equal to thirty-seven shillings per ton, or five times that of the chloride of zinc solution.

There can be no question, therefore, of the initial advantage, i. e., that of the actual price of the one material over the other. Should there be any necessity to transport the material to a distance, the advantage becomes more pronounced. The chloride of zinc is now manufactured in a solid form, which is fifty times as strong as the solution used for "burnettizing," the freight being thus reduced to *one-fiftieth*. In case of export, this is, of course, an immense advantage, which is further added to by the fact that chloride of zinc is absolutely *noninflammable* and is noncorrosive, and can be packed in either wooden casks or iron drums of an inexpensive description.

As to the mode of application, exactly the same plant as that used for creosoting is adapted to the use of chloride of zinc, and the same "modus operandi" is followed out, namely, that of injection under pressure in closed vessels, preferably after previous exhaustion of the air from the vessels.

In cases where it is not practicable to employ the usual apparatus for creosoting, and the timber has to

be submitted to simple immersion in the fluid for a longer or shorter time, the chloride of zinc has a great advantage over creosote oil on account of its greater fluidity and greater affinity for the soluble matters of the wood, which causes it to penetrate more rapidly and deeply into the pores.

Where simple "soaking" or "pickling" of the timber is adopted, the vessel used may be a tank of wood or iron, or may be of brick or stone sunk in the ground. At one establishment there are used two tanks or vats built in the ground with bricks. They are fifty feet by eight feet six inches and four feet six inches deep. The inside course is best of blue bricks, set in pitch, or ordinary bricks soaked in melted pitch. Such a tank will last for years without repairs, and will hold from twelve to fifteen thousand feet, board measure, of timber.

It is a noticeable fact that in the treatment of timber by absorption in this way, if it is immersed while containing sap, i. e., in a more or less green state, the chloride of zinc penetrates more quickly and farther than when dry, but the amount of material taken up is not so great.

After treatment with the chloride of zinc, it is the practice of some of the continental railway companies to give an outside coat of hot tar oil, in which some pitch has been dissolved.

The great importance of an extremely cheap and efficient mode of preserving timber, is apparent when it is borne in mind that in the form of railway sleepers and similar objects, soundness and durability are prolonged to some two to four times that of timber in its natural state, and seeing that the forests and timber supplies of almost all countries are rapidly decreasing in extent, the question of economically lengthening the period of usefulness of wood used for railway, mining, and other outside work, becomes one of almost national importance.

The object of this paper is chiefly to point out, that in this country it appears to have been quite overlooked that the admirable process discovered by Sir William Burnett, has now, through the develop-

ment of the manufacture of chloride of zinc, become the most economical method extant, for the preservation of timber from decomposition and decay.

For information as to processes carried on in America, the writer is much indebted to Mr. James Francis, of Lowell, in a paper read before the New England Cotton Manufacturers Association.

PATENTED PROCESS OF TREATING TIMBER.

CREOSOTING.

The improved process herein described of impregnating timber with preservative fluids, consisting in placing the timber in the retort with vents left open to the air, then introducing creosote in sufficient quantities to submerge the timber in the same, then heating the timber and the creosote to a temperature above the boiling point of the sap at ordinary atmospheric pressure whereby the sap is expelled from the timber, then closing the vents of the retort and by the application of pressure forcing the creosote into the pores of the timber to take the place of the evaporated sap, substantially as described.

Covered by Letters Patent No. 11,515 Dec. 3, 1895, issued to W. G. Curtis and John Isaacs of San Francisco, Cal., to whom application for right to use should be made.

This notice of this patented process is inserted by permission of the patentees, the author desiring to embrace all possible information of interest relating to timber preservation. The standing of these men—John D. Isaacs, C. E., and W. G. Curtis, C. E. (deceased), pioneers in the business, is such as to vouch for the value of the process. If, as it is claimed, the steaming can be omitted, there is a distinct saving of time and a corresponding saving in cost. It must be held in mind, however, that timber differs so radically in different parts of even the United States that its value can only be determined by actual trial. The statement of operation and of cost of treating, both Burnettizing and creosoting, here inserted, is furnished by John D. Isaacs, C. E., engineer of maintenance

of way of Southern Pacific Railway, and is so complete and well arranged that it is thought proper to give it place here. The cost of treatment varies considerably with locality. This is net cost to the railroad company and does not cover investment, interruption of operation or operators' profits, when the business is conducted as a commercial enterprise.

SOUTHERN PACIFIC COMPANY.

(Pacific System.)

STATEMENT OF COST OF BURNETTIZING CROSS TIES FOR THE YEAR ENDING JUNE 30, 1902.

At Dietze, Cal. (Portable Plant.)

Months, 1901.	No. of Ties Treated.	Absorption Zn. Chl.	Cost of Treatment Per Tie—Cents.				Total.
			Zn. Chl.	Fuel.	Labor.	Mainte- nance.	
July.....	(7x8) 49,062	.60	4.58	1.47	2.82	.57	9.44
	(6x8) 9,775						
August...	(7x8) 118,423	.60	3.79	.58	3.09	.10	7.54
	(6x8) 16,800						
Sept.....	(7x8) 96,096	.60	3.72	.05	3.22	.12	8.11
	(6x8) 11,198						
October..	(7x8) 99,302	.60	3.85	.08	3.00	.09	7.72
	(6x8) 19,412						
Nov.....	(7x8) 91,184	.60	3.90	1.29	3.12	.09	8.40
	(7x8) 10,049						
Dec.....	(7x8) 42,455	.60	4.07	.41	3.13	.67	8.26
	558,319	.60	3.89	.88	3.08	.19	8.05

Cost of moving and setting up..... .25

8.30

491,512 7x8 inch ties

66,807 6x8-inch ties—to 548,780 7x8-inch ties: cost per ties 8.20

At Latham, Ore. (Portable Plant)

Months, 1902.	No. of Ties Treated.	Cost of Treatment Per Tie—Cents.						Total.
		Absorption Zn. Chl.	Zn. Chl.	Fuel.	Labor.	Mainte- nance.		
Jan.....	(6x8) 8,908 (7x8) 97,777	.60	3.73	.84	2.79	.12	7.39	
Feb.....	(6x8) 75,397 (7x8) 21,267	.60	3.65	.73	2.60	.16	7.74	
April....	(6x8) 62,324 (7x8) 58,490	.60	3.78	.08	2.43	.37	6.66	
May.....	(6x8) 49,023 (7x8) 69,815	.60	2.69	.69	2.42	.08	5.87	
June....	(6x8) 20,540 (7x8) 38,142	.60	4.51	..	3.42	.70	8.63	
	496,776	.60	3.57	.51	2.63	.24	6.95	

Cost of moving and setting up..... 32

7.27

216,187 6x8-inch ties

280,591 7x8-inch ties—to 465,910 7x8-inch ties. cost per ties 7.41

At Oakland, Cal.

Months, 1901-1902.	No. of Ties Treated.	Cost of Treatment Per Tie—Cents.						Total.
		Absorption Zn. Chl.	Zn. Chl.	Fuel.	Labor.	Mainte- nance.	Oil waste and Water	
Sept.....	(7x8) 38,454	.60	3.77	1.23	2.30	....	.21	8.51
October..	(7x8) 69,151	.60	3.60	1.01	2.80	.38	.12	7.86
Feb. '02..	(7x8) 55,681	.60	3.66	1.08	2.84	1.10	.16	8.84
March....	(7x8) 88,880	.60	3.79	1.11	2.46	.47	.14	7.97
April....	(7x8) 18,991	.60	3.59	.90	2.36	....	.11	6.98
May.....	(7x8) 54,506	.60	3.73	1.02	2.65	....	.18	7.51
June....	(7x8) 84,304	.60	3.22	1.33	2.48	.55	.13	7.71
	409,947	.60	3.61	1.12	2.67	.42	.14	7.98

CREOSOTED TIMBER.

THE NORFOLK CREOSOTING COMPANY'S METHOD OF PRESERVING WOOD FROM MOLLUSKS AND THE ELEMENTS.

The preservation of timber by the Dead Oil of Coal Tar process, as carried on by all well-equipped creosoting plants, consists of two distinct operations—the preparation of the wood, and its impregnation with the preservative. The preparation of the wood necessary for the proper reception of the preserving substances is the removal of all those portions of the tissue which are subject to fermentative action. This consists of the extraction of the liquids and semi-liquids occupying the interfibrous spaces, and constituting the very immature portions of the wood, without softening the cement binding of the febrillæ, or bundles of cellulose tissue, forming the solid or fully matured part. Upon the successful accomplishment of this entirely depends the value of artificially preserved wood for structural purposes. If this step of the operation is conducted at too low a temperature, or for too short a time, the sap or liquid part nearest the surface will only be extracted, the consequence of which will be an insufficient space for receiving the preservative. If, on the other hand, the operation is carried on at too high a temperature, or for too long a time, the resinous portion of the bundles of fibrillæ will be softened and the wood lose its elasticity in just the proportion that the coherence of the fibrillæ is lessened. The temperature should never be less than 100° C. or exceeding 130° C. Of the two possible methods for the removal of the undesirable portions of the timber, exposure to currents of dry air, and steaming under pressure with an after drying in a vacuum, the latter is now the universal practice. While the first named plan may seem the more rational, and the one least likely to modify injuriously

the physical structure, such is not the case. Under proper manipulation, a more thorough desiccation, without harmful change of the organic structure, can be accomplished in twelve hours less by the latter process, than is ever possible with air drying which, under the most favorable circumstances, is a long-drawn-out operation, and cannot do more than extract the water from that portion of the sap which has not yet reached the semi-solid stage, thus leaving in the tissues of the wood a very considerable amount of resinous matter which occupies space that should be ready to receive the creosote oil. The consequence of this is a failure of the oil to reach many of the interfibrous passages, which are either left empty or are filled with the gelatinous part of the half-matured growth cells in which are to be found the conditions that make putrefaction possible. In order to remove the sap from wood, it is first necessary to vaporize it and then to bring about such external circumstances which shall allow outflow of all gaseous matter from the interior of the wood. In order to vaporize the sap it is necessary to break down the walls of the cells containing the liquid and semi-liquid substances. This is readily accomplished through the agency of heat applied through the medium of a moist steam bath, at such a pressure as to keep the temperature of the wood, and its surrounding atmosphere, somewhat above the boiling point of the sap. The maintenance of this condition for a few hours is found to be quite sufficient to break down the sap-cell tissue and to vaporize all those constituents that it is desirable to withdraw. This point having been reached, the steam bath is discontinued, and the temperature being maintained at, or slightly above, the vaporizing point of the sap, the pressure of the atmosphere surrounding the wood within the chamber is reduced below that of the interior of the wood. The result of this condition is an outflow of vapor and air, continuing until equilibrium is restored. This equilibrium is prevented by the use of an exhaust pump until the ab-

sence of aqueous vapor in the discharge from the pump indicates the completion of the operation. At this stage of wood tissue is in a state very like that of a sponge cleared of hot water; every pore is gapping open and ready to receive the oil.

In the practice of the Norfolk Creosoting Company the most carefully dried lumber is steamed and subjected to the action of the heated "vacuum" in order that there may be had that thorough and uniform penetration of the preserving liquid that is essential to the highest efficiency of the product. The timber having been thus prepared the creosote oil is admitted to the chamber, which is still kept under the influence of the vacuum pump, at a temperature somewhat above the boiling point of the sap, at the pressure then existing in the chamber. As the hot oil envelops the wood and enters the interfibrous spaces, the aqueous vapor yet remaining in the wood, by reason of its less specific gravity, rises to the top of the containing chamber and is withdrawn by the pump. By the time that the chamber is entirely filled with oil, all the remaining moisture has escaped. The exhaust pump is stopped and, in order to facilitate the absorption of the oil by the wood, a pressure pump is set to work supplying oil to the chamber at such pressure as may be desired. This operation is continued until the requisite amount of oil has been put into the timber. The chamber is then opened and the timber withdrawn. The apparatus is then ready for further use.

The successful conduct of the operation above outlined exacts the most careful attention and skillful management, supplemented by adequate and suitable appliances. The wide divergence in the characteristics of timber; the varying amounts of sap, due to the lapse of time since, and the season in which the tree was felled; its possible subsequent immersion in water for a longer or shorter time; the character of the soil and the conditions under which the tree grew, whether in a dense forest or a comparatively open country, whether it is of a rapid even

growth, or a slow intermittent one, are all factors contributing to a more or less perfect product. To the experienced operator these conditions indicate, in each case, the proper course to be pursued. Failure to observe and to take them into consideration is to invite indifferent, uncertain and in the end unsatisfactory results. Of equal importance is a proper understanding of the circumstances under which the finished product is to be used. Timber for piers, wharves and other structures in tropical waters demand processes and degrees of thoroughness of treatment that are unnecessary in the harbors of more temperate climates, which are, in turn, more exacting than land and fresh water construction.

The success of the Dead Oil of Coal Tar process owes its virtue to the presence of insoluble non-volatile substances indifferent to the attacks of oxidation or putrefaction, under the conditions to which its product is normally exposed. Of these substances, by far the most abundant are the Naphthalene compounds which occur in commercial dead oil of coal tar to the extent of from thirty to sixty per cent by weight. Naphthalene proper, the most abundant of the series, is in its pure state a white substance in the form of closely adhering rhomboidal crystals. It fuses at 79° C. and vaporizes at 212-220. Its specific gravity is 0.9778 at its boiling point. It is insoluble in cold water; sparingly so in hot; it is slightly volatile at normal temperatures.

SPECIFICATION FOR CREOSOTED TIMBER.

MATERIALS.—Timber shall be of the dimension specified, straight, free from windshakes, large or loose or decayed knots, red-heart or anything impairing its strength or durability, and to be cut from sound live trees, and to be . . .

OIL.—All oil shall be the heavy or dead oil of coal tar, containing not more than 1½ per cent of water, and not more than 5 per cent of tar, and not more than 5 per cent of carbolic acid.

It must not flash below 185° F. nor burn below 200° F. and it must be fluid at 118° F. It must begin to distill at 320° F. and must yield between that temperature and 410° F. of all substances, less than 20 per cent by volume.

Between 410 and 470° F. the yield of naphthalene must be not less than 40 nor more than 60 per cent by volume. At two degrees above its liquefying point it must have a specific gravity of maximum 1.05 and minimum 1.015.

PROCESSES OF TREATMENT.—Seasoning: This is to be accomplished by subjecting the timber to the action of live steam for a period of from five to seven hours at a pressure of 35 to 55 pounds per square inch, the temperature not at any time exceeding 275° F. unless the timber be water-soaked, in which case it may reach 285° F. for the first half of the period. At the expiration of the steaming the chamber shall be entirely emptied of sap and water by drawing off at the bottom. As soon as the chamber is cleared of all sap and water a vacuum of not less than 20 inches shall be set up and maintained in the chamber, for a period of from five to eight hours, or until the discharge from the vacuum pump has no odor or taste, the temperature in the chamber being maintained at between 100 and 130° F. The chamber being again emptied of all sap and water the oil is to be admitted, the vacuum pump being worked at its full speed until the chamber is filled with oil. As soon thereafter as is practicable such a pressure shall be set up as shall cause the entire charge of timber to absorb . . . pounds of oil within . . . per cent more or less (at a minimum penetration of 1½ inches in round timber for a treatment of 12 pounds of oil per cubic feet, constituting a basis for determining the penetration due to a treatment of any specific quantity of oil) . . . inches from all exposed surfaces. The depth of the penetration being ascertained by boring the treated piece with an auger, making a hole not more than $\frac{5}{8}$ inch in diameter, such pieces as are found not to

have the required penetration being returned to the chamber with a subsequent charge for further treatment.

INSPECTION.—Inspection shall be made as the work progresses, and at as early a date as is practicable, in order that there may be a minimum loss of time and materials due to rejections.

The inspector, or other authorized agent of the purchaser, shall have reasonable notice of the intention on the part of the contractor to begin the treatment of a charge of timber, and he shall have at all times during the treatment of the timber under his charge access to the works, and all reasonable and necessary facilities for ascertaining that all the requirements of this specification are complied with. Such "reasonable facilities" providing opportunity, at the proper time, for measuring all timber, treatment-chambers, oil-tanks, etc., and for taking samples of the oil being used, for analysis, as often as he may deem necessary.

NOTE.—All cut ends, mortises, tenons, and other incisions of the original surface of creosoted timber should be protected by not less than four coats of creosote oil, applied boiling hot with a brush or mop. In the case of mooring piles, fender piles, and other timber having the cut end exposed to the weather, the portions so exposed should have, in addition to the creosote oil, a heavy final coat of a paste made of equal parts of unslaked lime and creosote oil, applied hot.

NOTES ON CREOSOTING.

SOUTHERN PACIFIC PROGRAMME.

Naphthalene, requires 170 deg. Fahr. to liquefy.
Spec. Grav. at 60 deg.—1.050 Be.

Programme.

- (1) Vacuum 24 inches ten minutes.
- (2) Steam to temp. 125 deg. Fahr., 15 to 20 minutes.

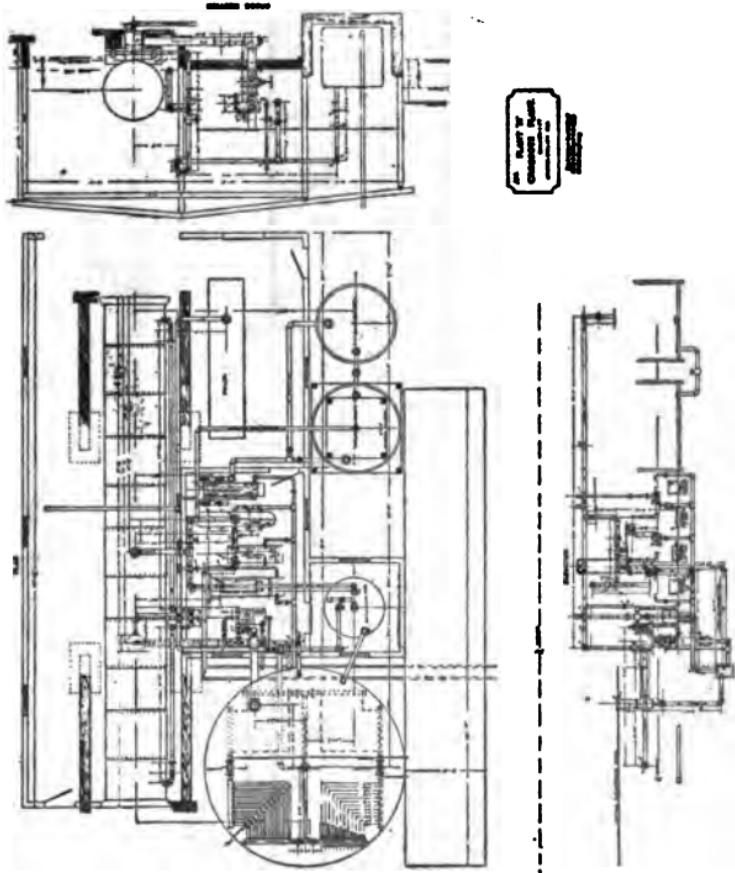


FIG. 49—OREOSOTE PLANT

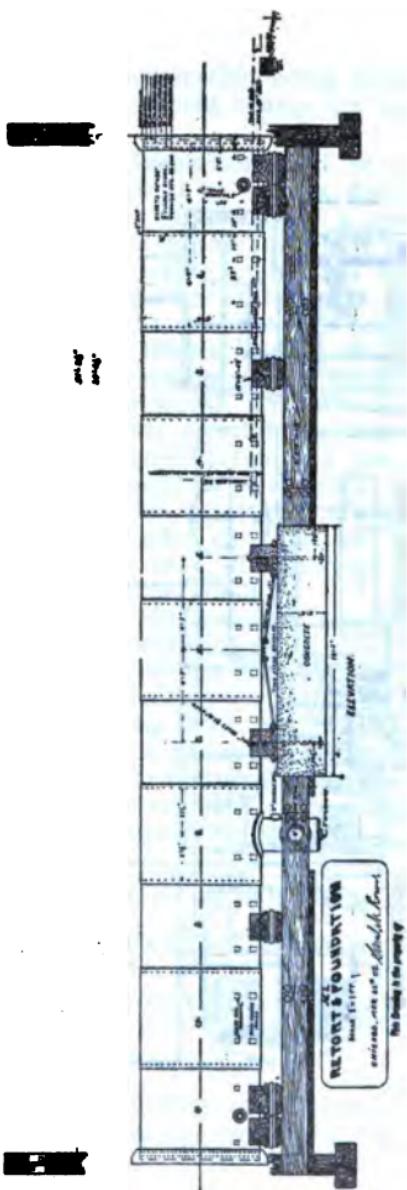


FIG. 50—RETORET AND FOUNDATION (DOOR EACH END).

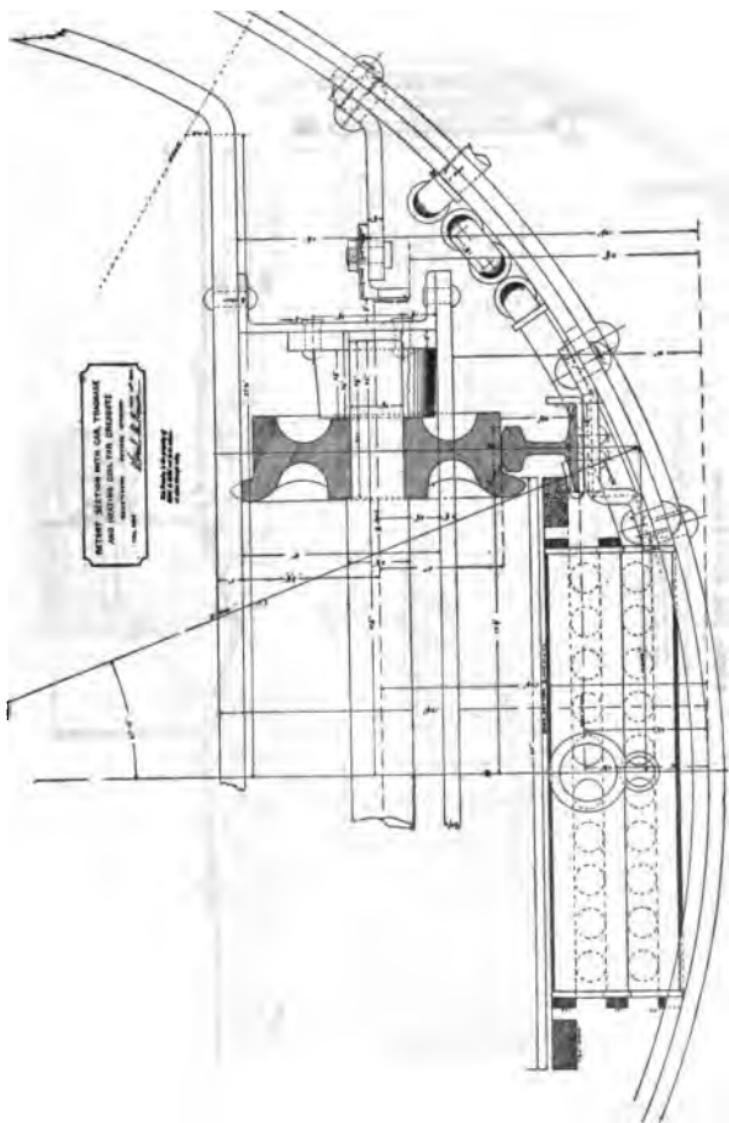


FIG. 51—RETORT SECTION WITH CAR, TRACKAGE AND STEAM COIL FOR CREOSOTING.

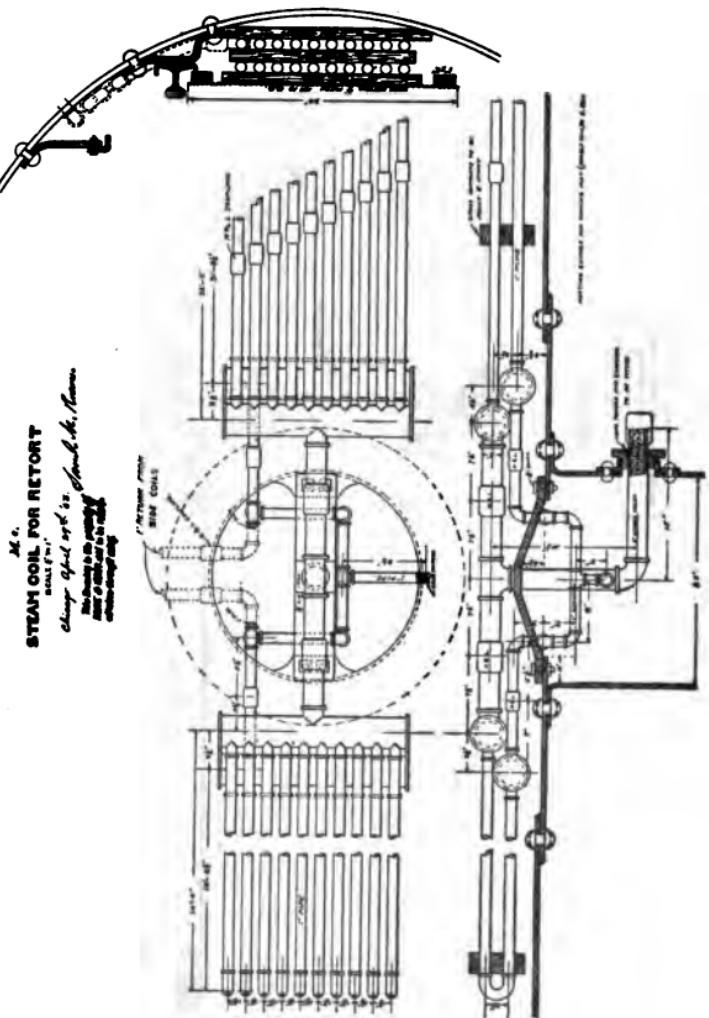


FIG. 52—STEAM COIL FOR RETORT.

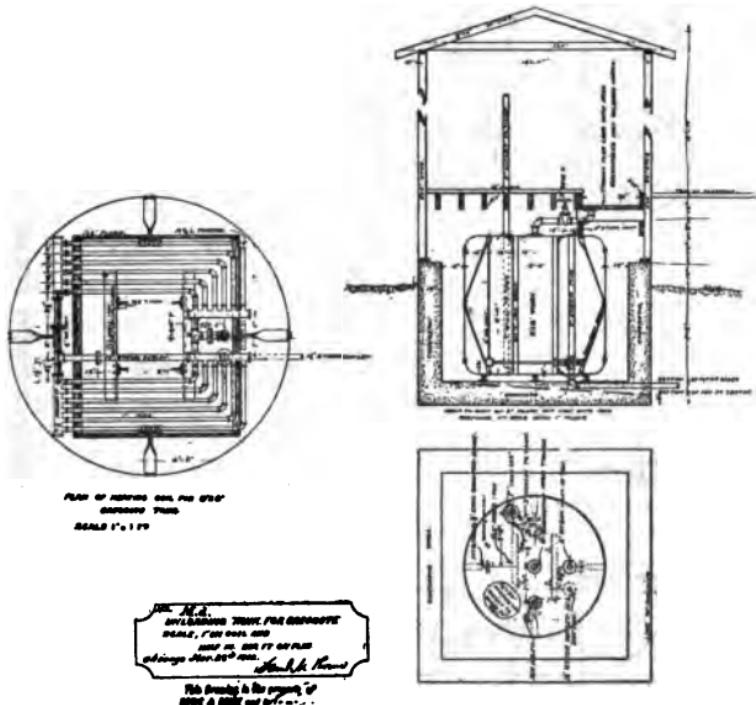
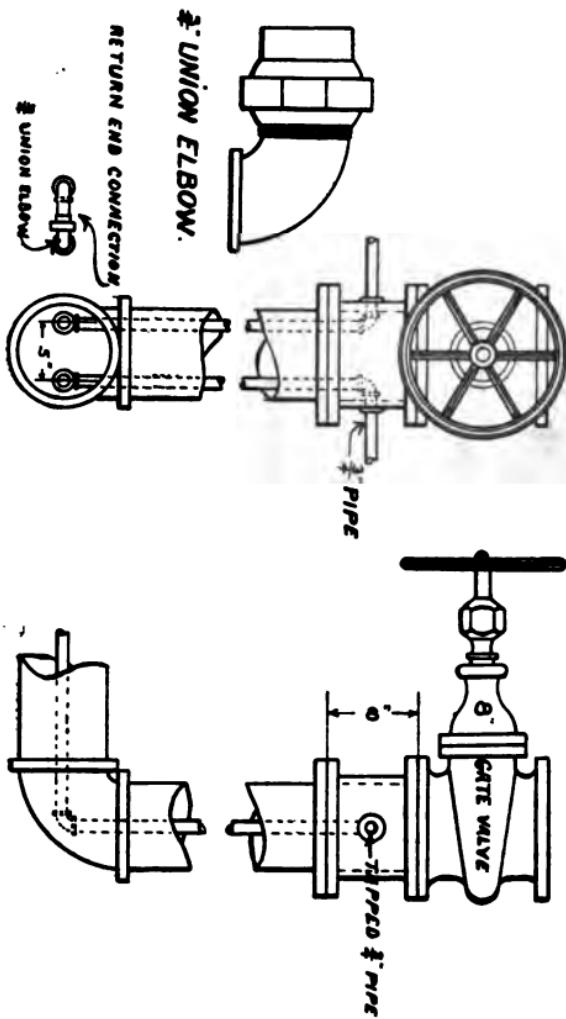


FIG. 58—UNLOADING TANK FOR CREOSOTE

FIG. 64.—SPECIAL CROSS FOR INSIDE STEAM PIPES.



SPECIAL CROSS FOR INSIDE PIPES
SCALE 1" TO 1"

Chicago Mar 18th 1903.

Sam. M. Howe.

- (3) Vacuum, 15 to 20 minutes.
- (4) Live steam at 30 lbs., 40 minutes, and kept up five (5) hours, temp. not above 250 deg. Fahr.
- (5) Blow off steam, 40 minutes.
- (6) Third vacuum to 24 to 26 inches for 90 minutes.
- (7) Introduce creosote oil at 170 deg. Fahr. and hold at 100 lbs. two hours.
- (8) Then force back and withdraw charge. Charge requiring about 11 hours to complete, including introduction and removal of charge.

Notes.—The Great Northern Railway of Ireland requires temperature of oil to be 120 deg. Fahr. and to be held under pressure of 100 lbs. for three hours.

RECORD OF CREOSOTING SOUTHERN PACIFIC RY.

The table given on the following page is compiled by John D. Isaacs, C. E. Engineer of Maintenance of Way of the Southern Pacific Railway. The table is a volume in itself in the way of valuable and authoritative information. The absorption of 1.15 gallons to 1.18 gallons is equal to about ten pounds to the cubic foot and \$15.96 to \$17.38 per M. B. M. is about 19 to 20 cents per cubic foot. Taking the mean, 20 cents, a 6"x8" 8-foot tie would cost 53.4 cents and an average tie of 3.2 cubic feet, 64 cents each.

**STATEMENT SHOWING COST OF CREOSOTING MA-
TERIAL AT THE SOUTHERN PACIFIC Com-
PANY WOOD PRESERVING WORKS
FOR THE YEAR ENDING
JUNE 30, 1902.**

At Oakland, Cal.

Months 1901-1902.	Ft. B. M. Treated.	Absorption Per Cubic Ft. Gals.	Cost of Treatment per 1,000 Ft. B. M.—In Dollars.					Total.
			Oil.	Fuel.	Labor.	Mainte- nance.	Oil waste and Water.	
July.....	829,128	1.15	13.45	.75	1.62	.12	.05	15.97
August..	392,580	1.12	12.84	.68	1.67	.66	.03	15.68
Sept	112,236	1.15	12.68	.78	2.10	.28	.06	19.88
October..	Not in operation							
Nov.....	545,160	1.15	12.56	.71	1.68	1.42	.05	16.42
Dec.....	912,792	1.18	12.27	.78	1.48	.24	.04	14.71
Jan. 1902.	839,964	1.15	12.47	.72	1.37	.69	.05	15.30
Feby	Not in operation							
March...	Not in operation							
April....	478,476	1.15	12.45	.87	1.94	1.91	.08	17.25
May.....	98,760	1.15	13.19	.65	1.23	5.17	.12	20.36
June	Not in operation							
Total....	4210,116	1.15	12.68	.77	1.60	.91	.05	15.96
<i>At Latham, Ore.</i>								
June, '02.	208,613	1.18	12.83	.61	3.90	.01	.02	17.38

RUTGER PROCESS.

ZINC CREOSOTE PROCESS.

Impregnation with Chloride of Zinc solution with an Admixture of Tar Oil Containing Carbolic Acid, According to a Process Invented and Introduced by Julius Rutgers.

The process consists of three operations:

1. Steaming the timber.
2. Producing a vacuum and admitting the preserving fluid.
3. The application of the pressure pump.

The impregnation is to be carried on by exactly the same process as prescribed for the chloride of zinc solution alone, in the preceding part A of this specification. The same conditions will obtain concerning the composition of the chloride of zinc solution and guarantee for the absorption of the preserving fluid. While the chloride of zinc solution is being heated, an amount of 2 kg. of tar oil shall be added to the solution for each tie of a length of 2.50 m. and over, or 20 kg. tar oil for each cubic meter of timber.

The mixing of tar oil with chloride of zinc solution shall be done by means of an efficient mechanical device, and a jet of steam and air.

COMPOSITION OF THE TAR OIL TO BE USED.

The tar oil must contain not more than one per cent of oils that boil below 125 deg. C. (257 deg. F.).

The boiling point of the tar oil as a whole must lie between 150 deg. and 400 deg. Celsius (302 and 752 deg. F.) and not more than 25 per cent must become volatile below 235 deg. Celsius (455 deg. F.).

At least 20 to 25 per cent of its constituents must be acids dissolving in caustic soda lye of 1.15 spec. grav. (oils of the creosote or carbolic acid type).

At 15 deg. Celsius (59 deg. F.) the tar oil must be completely fluid and must be free as possible from naphthalene, so that when distilled in glass vessels, in groups of 50 degrees each (fractional distillation), it should give off not more than 5 per cent of naphthalene. The specific gravity of the tar oil at 15 deg. Celsius (59 deg. F.) must lie between 1.020 and 1.055.

O. Chanute, M. W. S. E. March 21, 1900.

"CREOSOTING" BY JULIUS RUTGERS.

Impregnation with Heated Dead Oil of Tar Containing Carbolic Acid, According to a Process Invented and Introduced by Julius Rutgers.

The treatment consists of two parts:

1. The drying of the timber—i. e., withdrawing the moisture from the wood by means of heated oil of tar and the action of an air pump.

2. Pressing the oil of tar into the wood by means of a pressure pump.

I. DRYING THE TIMBER.

The timber to be impregnated is introduced into the impregnating cylinder which is then hermetically sealed. A vacuum of 60 cm. (23.6 in.) of mercury is then produced and kept up for 10 minutes. The oil of tar, previously heated, is then introduced into the cylinder, to such a height that it cannot be "sucked over" by the air pump, the vacuum being continuously maintained.

The admission of the heated oil of tar is completed at a single operation or with interruptions, according to the dryness of the timber.

During or subsequent to the filling, the oil of tar in the cylinder is heated to a temperature of not less than 105 deg. C. (221 deg. F.) and not more than 115 deg. C. (239 deg. F.) by means of steam, using a coil lying in the lower part of the impregnating cylinder, or a tubular boiler placed underneath. This heating should occupy a period of at least three

hours. After the required temperature is reached in the cylinder it must be kept up for a further period of 60 minutes, either with or without a vacuum, according as it may be necessary in order to ensure the absorption of the specified amount of oil of tar.

As soon as the filling of the impregnating cylinder with heated oil of tar begins, it must be connected with the condenser, which serves to condense all the aqueous vapors that escape from the wood and to conduct all the water of condensation into a vessel intended to receive it. This vessel is provided with a water gauge on which the amount of water evaporated may be read off.

II. PRESSING IN OF THE OIL OF TAR.

After the drying of the wood—i. e., the removal of water from the wood is completed—the tank is filled completely and a pump is put into operation which will produce a pressure of at least 7 atmospheres (103 lbs. per sq. in.). This pressure must be kept up at least 30 minutes for pine or beech wood and 60 minutes for oak, or longer time if it shall prove necessary, in order to insure the absorption of the specified quantity of oil of tar.

This completes the impregnation of the timber and the oil of tar is then drawn off.

COMPOSITION OF THE OIL OF TAR.

The oil of tar must be made from mineral coal tar and must contain not over one per cent of oils that boil below 125 deg. C. (257 deg. F.). The boiling point of the oil of tar as a whole must lie between 150 deg. and 400 deg. C. (302 and 752 deg. F.), and the larger part of it, at least 75 per cent of the whole, must not boil below 235 deg. C. (455 deg. F.).

At least 10 per cent of its constituents must be acid dissolving in caustic soda lye of 1.15 sp. gr. (Oils of the creosote or carbolic acid type.)

At 15 deg. C. (59 deg. F.) the oil of tar must be

completely fluid and free from fatty constituents, so that when poured out on the dry end surface of a timber it will soak into the wood immediately and leave only an oily residue. It must further be free as possible from naphthalene and at 15 deg. C. (59 deg. F.) must give off no naphthalene.

It must contain no oil of specific gravity less than 0.9 (or at least not over one per cent of such oils), while the specific gravity of the tar oil itself at 15 deg. C. (59 deg. F.) must lie between 1.045 and 1.10.

It must also be of such consistency that it is retained in the pores of the timber as much as possible after impregnation. Oils made from bituminous substances may be added to the mineral tar oil to an amount not exceeding 15 per cent, but the mixture must possess the same properties as are specified above for mineral tar oil.

O. Chanute, M. W. S. E. March 21, 1900.

THE RUPING PROCESS. EMULSIONS OF TAR OIL.

Owing to the fact that tar impregnation is far the best, but that its general use is prevented by its high price, trials have been made with the view of making the process cheaper.

These trials are based on the undoubtedly correct opinion that, considering the high antiseptic qualities of tar, only minor quantities would be sufficient to protect wood against decay in all its parts capable of impregnation.

The trials began with the object of introducing vaporized tar into the wood, but they failed merely because tar oil vaporizes at from 250 to 300 centigrades of heat. Wood being unable to stand such a high temperature and because the vapor condenses on the outer layers of the wood.

Therefore the trials were changed inasmuch as the tar was thinned—i. e., diluted with water.

At the same time two methods have been proposed in this respect.

According to the first, the wood is impregnated in a tar-oil emulsion obtained by mixing the tar-oil with a watery solution of resinous soap. The water of the emulsion is later removed from the wood by drying, the other ingredients remaining in it. In this emulsion the tar is distributed into innumerable globulets enclosed in soap, and by this means prevented from reuniting. But the tar enclosed in this manner is hardly able to come in direct contact with the walls of the cells and therefore cannot produce its high antiseptic effect.

According to the other method resinous oil is treated with concentrated sulphuric acid and the produce obtained in this manner is used as a dissolving means for the tar-oil, which then can be mixed with water. But this is questionable, whether the acid has not so bad effect on the tar-oil that the latter loses its quality as a first-class antiseptic.

Both the processes, however, have a common fault.

In thus impregnating wood, water is the only ingredient of the emulsion that penetrates into all parts capable of impregnation, not the tar itself. The globules of tar can on certain places only penetrate a few centimeters into it, owing to the filtering capabilities of the wood.

How powerful the filtering qualities of wood are can be seen by the fact that it is capable of separating the salts from salt solutions, which is all the more surprising because there does not exist any salt in concrete particles, as is the case with emulsions. This quality of wood has been applied in trials to make water drinkable by pressing it through wood.

Under these circumstances it should be clear to anybody that, as already mentioned, in impregnating with an emulsion the particles of tar are already kept back by the upper layers of the wood and

that consequently only the water can penetrate into the interior of it.

THE PROCESS.

According to the previous explanation a practical, lasting and at the same time cheap preservation of wood, especially of railway sleepers, telegraph poles and mining timber, can be effected neither by the noted metallic salt impregnation nor by the above mentioned tar impregnation. Knowing this, our firm tried to solve the problem by another way and after many attempts of the kind, our partner, M. Ruping—owing to the encouragement of Geheimer Postrat Christiani—finally succeeded in inventing a method of tar impregnation, which is exempt from the faults of the other methods.

Whilst by the former methods of tar impregnation the cells, pores and other cavities are entirely filled with tar, in consequence of which it may be called full-cell tar impregnation, or for shortness, full cell impregnation, our process is devised to do exactly the reverse.

The cells are intended to remain more or less empty, just as is wanted, and only their walls are to be coated or impregnated with tar-oil, a process which can be called empty cell tar impregnation, or, for shortness, empty cell impregnation.

Before entering upon the explanation of this new process we ought to shortly mention the usual tar impregnation in order to explain more definitely the differences between the two processes.

In the so-called full cell impregnation the wood, after drying in the open air, is put into an iron boiler, which has to be made a vacuum, so that even the air enclosed in the cells of the wood be removed. Then the tar-oil is caused to enter the impregnating boiler, and afterward the fluid is kept under a pressure of from 5 to 8 atmospheres, by which means it will be forced into the cells of the wood. Finally the pressure is taken away and

after removing the unabsorbed tar remaining in the boiler the process of impregnation is finished.

In the new Ruping process the seasoned wood is for some time (from about a half hour to an hour) exposed to a pressure of 5 atmospheres in the boiler —F—so that all the cells must be filled with air.

This is the principal difference between the old and the new method: with the former the air was removed from the wood cells by vacuum, whereas on the contrary with the latter, the wood is filled with compressed air.

Without reducing the pressure in the impregnating boiler F, the warmed impregnating fluid is then forced from the tar reservoir T into the impregnating boiler F by means of a somewhat higher pressure, say of about $5\frac{1}{2}$ atmospheres. In proportion to the amount of tar entering the impregnating boiler F, air is permitted to escape through the valve V, in order to make room for the required amount of fluid. At the same time, however, it must be kept in mind only to let such a quantity of air escape as cannot impair the consistency of the pressure of 5 atmospheres.

When the wood in the boiler F is completely covered with the fluid, the pressure, according to the dimensions and qualities of the material, is to be increased up to 15 atmospheres. Under this increased pressure the fluid will enter into the cells of the wood.

Now, one should believe that though the violent advancing of the fluid (in this case of the tar) the compressed air contained in the wood must be forced into the interior of it and there form a kind of basin which would render an impregnation of this part impossible, but this, according to trials made on a large scale, has proved not to be true. Owing to the high pressure, the tar-oil, in consequence of the capillarity of the wood and the adhesion, moves along the cell walls into the inmost parts of the wood, soaking them entirely, by which the compressed air contained in the cells will be

more compressed and at the same time entirely enclosed by the advancing tar.

When the material is sufficiently impregnated, the pressure is to be reduced and the fluid is permitted to go back into the reservoir T.

The compressed air enclosed in the cells will, with great energy, through its expansion, force as much of the impregnating fluid out of the wood as does not stick to the cell walls.

This is what forms the principal effect in the Ruping process.

Accordingly there can remain no more fluid in the wood than is exactly necessary for impregnating or coating and soaking the cell walls, etc., which is the only important object in view in the preservation of wood.

The oozing of the superfluous tar can be still increased and accelerated by exposing the impregnated wood to the effects of a vacuum for some time. Of course, in each case the pressure can be fixed in such a way that only the quantity of fluid, which is wanted, remains in the cells of the impregnated wood.

Refer to "The Ruping Process," by Mr. M. Ruping. Patented in Germany, No. 138,933; patented in England, No. 6844; patented in U. S. A., No. 709,799.

THE HASSELMANN PROCESS.

COST OF CHANGING BARNETT PLANT TO USE THE SYSTEM.

First, and most important in cost, will be two large bricked and plastered cisterns to hold the solution used. These cisterns should be 20 feet in diameter in the clear and 8 feet deep, with plank covering about at level of the ground. These could be placed outside the rear of the building and will have to be connected with the retort to be used for the purpose, by a system of ample large pipe by which the solutions will be quickly conveyed back and forth.

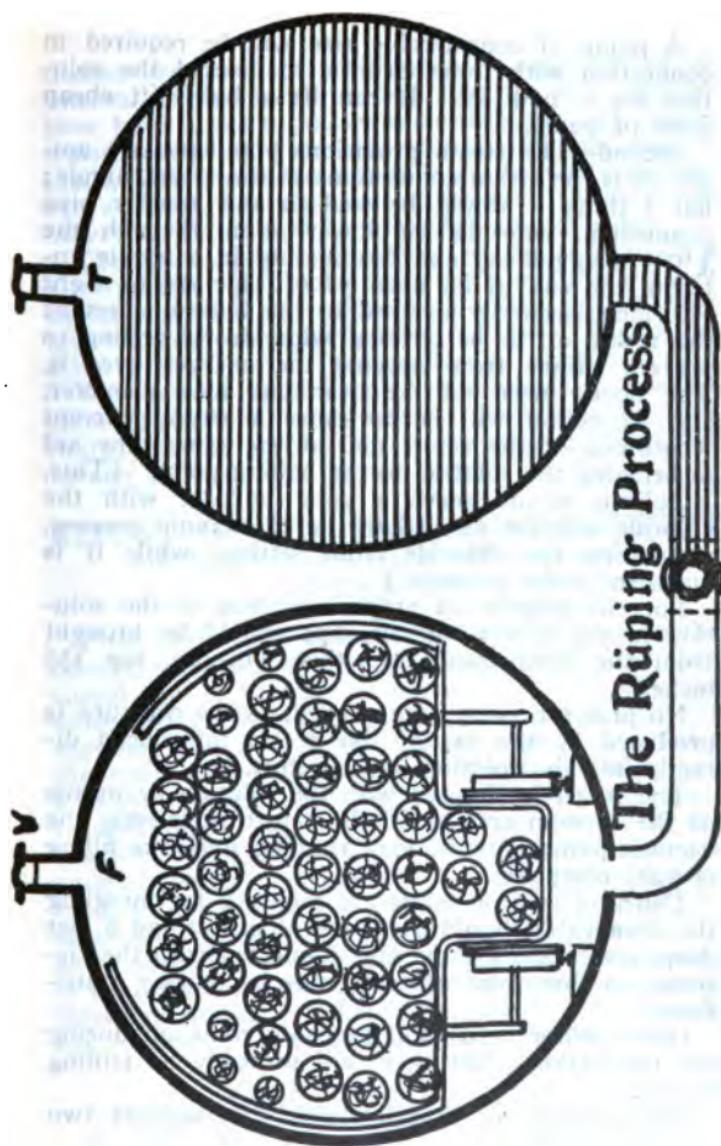


FIG. 64—THE RÜPING PROCESS.

A pump of considerable size will be required in connection with these cisterns to discard the solution for a new lot. It can be a light lift cheap form of pump.

Second—The steam provisions you have are ample, so is the steam connections to the retort, ample; but I think it would be well to add another pipe connection, entering the lower dome through the 3-foot plugged tap and terminating in a nozzle entering the end of an open 3-foot pipe six or eight feet long, securely fastened to the bottom sheet of the retort, all to be covered with strong netting to prevent injury from moving the charges over it. The nozzle need not be over one inch diameter, and its action will be to cause a strong current lengthwise of the retort and at the same time aid in bringing the solution to the boiling point. (This, I believe, would serve a good purpose with the chloride solution as well in the zinc-tannin process, preventing the chloride from settling while it is quiescent under pressure.)

For the purpose of proper agitation of the solution in the cistern, an air pipe should be brought from the compressor for this purpose, say 1½ inches.

No pressure pumps are needed, as the pressure is produced by the use of live steam introduced directly into the solution in the retort.

The retort is charged with the solution by means of the vacuum and to fill the retort sufficiently the vacuum pump must be kept running until the filling is quite complete.

Third—Two iron tanks are required for mingling the chemicals; should be 10 feet diameter and 8 feet deep, set on the ground and connected with the cisterns, so that their contents may be quickly transferred.

Other minor items will probably come up during the undertaking, but they will probably be trifling in cost.

The process, as I understand, contemplates two

distinct treatments or boilings to be separated by an interval of two to three days that the first application have time to disseminate through the piece; consequently eight or ten runs of the first can be made, then the other can follow. If plenty of cars are at hand, the charge can be held on the cars, otherwise they must be unloaded and reloaded.

The first application consists of the salts of iron (presumably Fe-2), sulphate of aluminum (presumably alum.) and sulphate of copper (presumably blue vitriol), in the proportion of one of the chemicals to 30 of water (presumably in weight).

The second application is composed of calcium chloride (Calc-2) and milk of lime (calcium hydrate), in the proportion of one pint to 50 of the former and one to 40 of the latter.

REPORT OF THE HASSELMANN SYSTEM OF IMPREGNATION OF TIMBER. OPERATION.

First, the timber is loaded on cars and put in the retorts, same as other systems; the retorts are then closed and a vacuum is pumped for one hour or more; after which the solution is turned in with the vacuum still on. When retort is very near filled the main valve is closed, and live steam is turned into the solution and distributed through by a perforated pipe; the solution is then heated to 245 degrees to 260 degrees Fahr., which will indicate a gauge pressure of about 35 lbs. The timber is then held in this boiling solution for a time from two to three hours, and then the solution is drawn off; or, as in practice, Mr. Weinier, the man in charge, says is changed from one retort to the other in waiting, then the timber is taken from retort and is ready for shipment. The process is very simple.

SOLUTION OF BATH.

Is a mixture of one and one-half per cent solu-

tion of sulphate of copper, a one-half per cent solution of sulphate of aluminum, and potassium of sulphate, in proportion accordingly to the condition of the timber, which seems to be one of the secrets of the system.

"THE CREO-RESINATE PROCESS."

This process* differs from the ordinary creosoting process in that instead of using live steam to sterilize the blocks, which are 4 by 4 by 8 inches, dry heat applied at a temperature of 250 degrees Fahrenheit, and under pressure of one hundred pounds to the square inch is used. The air pressure prevents the checking of the block, and the heat and pressure are held until the center of the blocks reaches 212 degrees, thereby destroying all germ life in the timber, which is the primary cause of decay. The heat is then reduced to 150 degrees, after which a vacuum of 26 inches is created, under which the cylinder is run full of creo-resinate mixture, which consists of 50 per cent creosote oil, 48 per cent resin and 2 per cent formaldehyde. Pressure is then applied by means of force pumps, and the mixture is forced into the blocks until every pore is penetrated and 22 pounds per cubic foot of the mixture is absorbed. The blocks are then run into another cylinder and treated with a solution of lime at a temperature of 212 degrees, and under pressure of 150 pounds to the square inch. They are allowed to cool off gradually, and are then ready for market.

NOTE.—The author has examined specimens of paving blocks treated by this process and would think it a very good process for paving blocks. No information as to mode or cost of treating has been obtained.

*Controlled and used by the United States Wood Preserving Company, New York.

THE VALUE OF TREATMENT OF TIMBER

It is our desire here to give a conservative view, as we in searching for the truth can hardly afford to deceive ourselves or the interested public and those especially concerned. On the other hand, it would be equally foolish to depreciate results when we have the means to arrive at what is demonstrated as probably near the truth; as near as human intellect can discern and near enough to be accepted as practically true.

What is here advanced is the summing up of observations and study of the subject. This investigation has required many months of close study, during which the closest and most searching analysis of the recorded results with the various collateral influences, have been considered and allowed for. To the management of the A. T. & S. F. Railway Company is due the highest degree of credit for the careful and comprehensive record that has been kept and to this in a great measure is due the conclusion now proposed to be given. The record here dealt with closes with the record of 1902, none later being available, seventeen years from the start in 1885, an elapse of time sufficient to give something sufficiently definite on which to base measurably reliable conclusions. Unfortunately the record of tie removals was not taken up until 1897, twelve years after the first ties were treated, so that the number of ties failing during that interval will necessarily have to be estimated.

The removals of ties treated in the years subsequent to 1897, down to 1900, however, will give us an approximate rate of removal in the earlier years that will guide somewhat. By means of this record a close approximation is made of the percentage of the treated ties removed each year. We take it for granted that measurably correct conclusions can be derived from the mean of a large number of results for the same

lapse of time, and further, that causes acting as does the decay of timber under similar conditions, in various periods during its history will, if graphically recorded, form a curve. In line with this we have first laid down a line showing the percentage of ties removed each year, being the mean for all the years recorded, that portion not covered by the record being derived from the mean of removals in the early years of those subsequently treated. The bottom line of the table shows the percentages so derived, and the curved line "a" on the diagram the same graphically disposed.

We find, however, that according to this the ties treated in 1885 should have been exhausted in the seventeenth year, while it has been found by somewhat extended inspection that many of the 1885 ties are still in service and good for many years longer. There are probably 20,000 of these ties in yet, certainly 15,000, hence we are obliged to reduce the estimated percentages for the earlier years where we have no record, and apply it to the 1885 ties alone, as shown by the line "b" on the diagram. A careful and extended inspection of the condition of all the ties so far as extended shows that those treated in the earlier years are giving a better record than most of the subsequent years, so far as now determined. It is not for me to say here what are the reasons, but the result as shown in the present conditions of the ties of the various years is patent. The 1885 ties and those treated in the three or four years subsequent (1886, 1887 and 1888) are almost identical in general appearance, with condition as to soundness almost in the same ratio, and can safely be expected to give a record eventually about equal to those of 1885. They are characterized by the manner in which decay progresses, commencing at the surface in contact with the earth, and continuing, the fiber being destroyed regularly in succession as it passes upward, leaving many of those ties now fourteen to seventeen years service, with almost half of its timber sound enough to make good fuel.

Those of subsequent years show that decay spreads through the body of the tie at a much earlier period.

Whether this is due to poorer quality of timber, leaving the timber on the ground without being piled to dry, or to improper or hasty treatment, cannot now be said. The two former are the most probable causes, however.

That the results here shown by these earlier treated ties should be taken as a sample of what can be done seems reasonable. All but a few of these ties were treated by the "Wellhouse" or Zinc-tannin process, and have given a record that should not have been lowered in subsequent treatment. Here we have up to 1900 enough treated ties to lay 1,888 miles of track, 3,872,500 ties treated, removals in same time at an average of 8 year or 11,000 *year miles*, equal to 961,654 ties, or 87.4 ties per annum per mile, the mean number of ties removed in ordinary practice being from 250 to 300 where ordinary run of ties is used.

In this tabulation all ties removed, whether on account of decay or of breakage from derailments or from premature removal in relaying rails or in ballasting are included. It is well known in practice that many ties that may still serve for several years are, after being disturbed by relaying rails or in ballasting, removed to give place to new ties. The proportion of removals for other causes than decay is estimated at not less than five per cent and may be as high as ten per cent, but as this loss is common in all cases, it is deemed best not to consider this in connection with this matter, but to include them all in this estimate.

Right here it will be proper to survey the subject of inspection with reference to the "personal equation," that effect that creates a variety of impressions almost as varied as the number of observers. The writer believes that the searcher must trust to extended and repeated observation until the mind has absorbed and assimilated every aspect of the subject so that instinct is trained, as it often becomes, in, for instance, the recognition of the great variety of timbers, as often occurs with experienced lumbermen, in which case he can unerringly name each variety without being able to put this description into words.

This is found to be equally true in recognizing the various conditions shown during the years of exposure by the ties in track. Verifying this is the corroborating experience of others, who have aided much in this investigation.

In making the recent inspection of the Santa Fe it was found that Mr. Daniel Elliott, the roadmaster who had been on his division ever since a short time previous to the commencement of using the treated ties, could walk along the track and almost invariably name the year the tie was treated without looking at the brand of the stamping hammer. On the other hand, a large majority of those that had equally good opportunity to observe could see little or no difference between one and another. In one case a section foreman who confessed to have been engaged on a section for over ten years, where treated ties were in the track from some previous year, to the extent of twenty-five per cent, was unaware of their presence and could tell nothing as to their value compared with cedar ties along side of them, which were cut one-quarter of the depth by the rail, while the treated ties were almost invariably sound and but little rail-worn. We thus can easily conceive how the value of the results can be beclouded by lack of careful intelligent study.

In the inspection of treated ties care has been taken to gather all the information possible from those treated by the same process outside of that on the Atchison, Topeka and Santa Fe Railway. Those treated at Chicago by the Chicago Tie Works and distributed on various portions of the Chicago, Rock Island and Pacific, some of which have been in service for fifteen to seventeen years, the result seems to be equally good as those on the Santa Fe. The methods used in treatment are essentially the same as those introduced at Las Vegas in 1885, and it is believed will make just as good a showing. Some samples of treated hemlock on the C. R. I. & P. and also in the Rock Island and Peoria Railroad with a number of samples from the A. T. & S. F. were exhibited at the last spring meeting of the American

Railway Engineers and Maintenance of Way Association in which the fiber of the timber was still sound at fourteen to sixteen years.

The treatment of Texas pine commenced in 1897. After six years of exposure, some begin to show decay, but this is mainly confined to the lowland short leaf pine (Loblolly). A careful inspection of two miles of the Dallas branch showed one in sixty of these ties to be decayed so as to justify removal. The roadmaster, however, thinks that a much larger proportion are failing. It is, however, too early to draw anything like definite conclusions in this case. The climatic conditions there are not so favorable as in New Mexico or Colorado. Ties made from this kind of timber in Eastern Texas have been known to rot so as to be worthless in two years and not one in a thousand fit to put in track in three years.

On the same line at six years, the treated ties which were cut from heart timber or well matured trees were very much better than the Loblolly pole ties before mentioned. It will be seen that a small percentage of the treated ties in New Mexico give out in the sixth year and scarcely any before that, while from the recent inspection some of the 1885 ties will be in service from appearance up to nearly twenty-four years.

The value of the treatment by the "Wellhouse" process must be conceded, taking such records as are now available both as to this process and that of the Burnett or simple chloride of zinc, to be the best probably in proportion of near twelve years for the former and eight years for the latter, or fifty per cent in favor of the former. It must, however, be remembered that the statistics are also subject to the "human (not personal) equation" and that it may be years before this question can be settled, but, to go back to the main question of the economic value of either; the one's relation to the other, depending as it does somewhat on climatic conditions may be indeterminate for the present.

Whether it is determined or not, the reduction of renewals from "twenty-five per cent to five," as once

stated by a railroad official who has been in a position all the time to judge as well as anybody living, even if proved to be too sanguine, which it does not appear to be at the present time, and in view of the foregoing figures, should go far to settle the question of economy.

The renewals now seem to be under four per cent, or about 100 ties per mile per year. It is, however, a fact that the untreated mountain pine ties first laid in New Mexico, did come out at the ratio stated and the tie question at that time was such as to appall the management.

The appearance of the treated timber is found to guide somewhat as to the condition as to progress of decay and may guide in determining the reasons of failure, whether due to failure to carry out the proper treatment or to other causes.

As before stated, the 1885 to 1888 ties are characterized by a certain freedom from longitudinal and end checks, while those of subsequent years have the checking quite marked, giving the tie the appearance of being split into many strips. When these ties are taken out they go into strips sure enough. Another feature is the manner in which the decay progresses. A case in point will illustrate the way that decay progressed in the 1885-1888 ties. A large number of these ties after three years in track in one marked case, were broken in two pieces by the engine driver wheel flange in a bad derailment. Examination showed a layer of decayed wood on the bottom and up the side as far as the earth was in contact, about one-quarter of an inch in thickness in which the wood was entirely decayed, the balance of the tie remaining entirely free from appearance of decay, not even incipient. This applied to every tie, nearly a hundred in number.

Quite a number of the ties treated the same year, 1885, or the two or three following years, when removed in the course of the recent renewals after from fourteen to seventeen years' service, showed the same method of progress of decay, i. e., from the bottom upward so that about half of the volume of

the tie was gone, but the remaining upper half was still sound enough for good fuel.

Ties treated in some of the subsequent years showed decay permeating the body of the tie irregularly and the tie when removed would go all to pieces.

The mean life is that which represents the sum of the life of all divided by the number, and this method is here used and is evidently the only practical measure.

Perhaps the best illustration of this manner of progress of decay will be the facts as they occur.

The year in which the ties are put in the track is the starting point. The year in which the first ties fail is another step, the rate from there on is the curve of failure and the year at which the last are removed is the culmination. It is here attempted to place a close approximate value to these various terms. If every piece was exactly alike in texture, density or soundness, all should fail at once, but this is never so. It would be very interesting to know what the curve representing the life of the untreated timber of various kinds really is. This so far seems never to have been recorded so far as we know, and here is a difficulty we encounter when comparing the treated ties with the same untreated. The life of the Rocky Mountain pine has been variously estimated at from a mean of from five years down to four or even below, and the fact, according to some of those best versed, is that four and a half years is about right. Then if the "Wellhouse" treatment gives a mean of near twelve years, we have nearly trebled the life. Mr. Elliott is quite sure that this estimate is a conservative one, and the figures so far indicate nearer fourteen years than twelve.

The Wellhouse process, it is claimed, derives its advantage over the simple chloride of zinc (Burnett) process, in this, that the leatheroid produced on the surface and in the end pores of the wood by the combination of the glue and the tannic acid retards the ingress of water. That it does so seems to be quite well authenticated.

In the simple process of immersing one sample

block of wood after being treated and a similar block say from the same tie without treating will corroborate this, it being found that the untreated block will at first absorb the water the most rapidly, although eventually the treated block will absorb the most. The latter effect seems to be due to physical changes in the wood during treatment, the solubles in the timber having been dissolved and removed by the cooking.

Critics claim that the deposit of the glue is so superficial that it cannot do much good. It is true that owing to the viscosity of the glue it cannot penetrate the wood to any appreciable depth on the sides, but yet it does penetrate to a considerable depth at the ends by means of the sap ducts. It is the result that justifies its use, however, after all, and no specious theorizing can upset the facts.

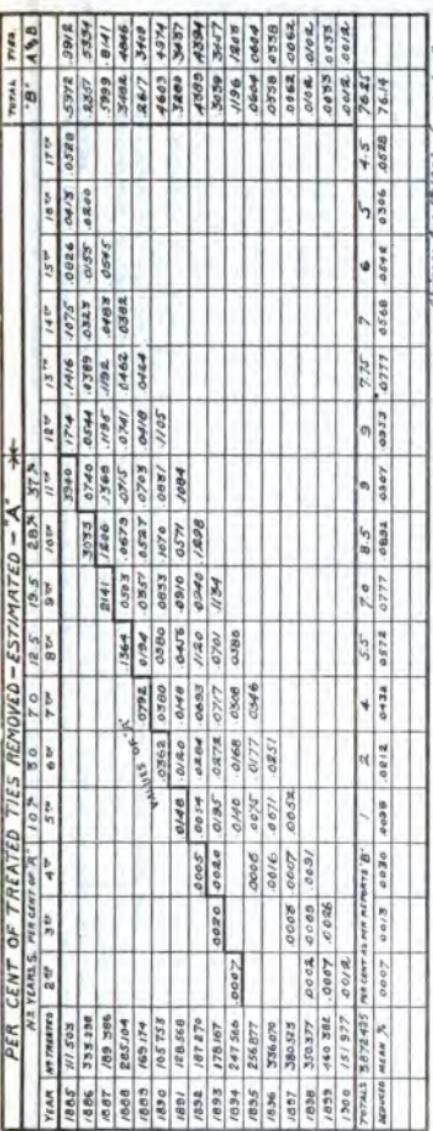
The writer has felt it a duty to embody the result of observation and study of this matter of timber preservation, using the utmost candor, giving facts as they seem to be well authenticated.

Time and further experience may show some of these conclusions to be fallacious and as regards the figures given and the resulting conclusions and deductions may prove sanguine but what the figures say cannot be gainsaid without future data only to be gained by the lapse of time. For instance the figures seem to show that the mean life of the treated ties shown might be twenty years.

This is, however, not conclusive as the next few years may necessitate as much greater renewal of ties from causes such as heavier rolling stock, traffic, etc., or by reason of larger renewals due to lax removal previous to this time.

A great many ties may be still in track that should be out or poorer quality of timber may only be available owing to the exhaustion of the supply of the better class of timber. It is most probable that the Santa Fe estimate of eleven to twelve years is a near approach to the true life of the pine tie, although, as Mr. Mudge properly says, the longer mean life of the later renewals will tend to increase the general average.

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Chicago Aug 3rd 1907 Frank H. Home:

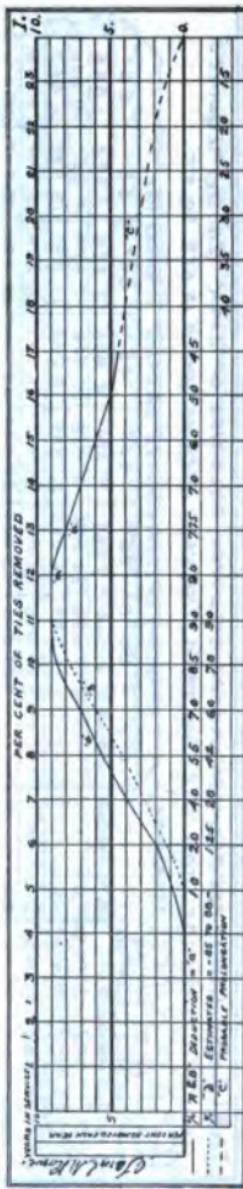


FIG. 68—PER CENT OF TREATED TIES REMOVED.

TABLE-B—CUBIC FEET CONCENTRATED SOLUTION, CHLORIDE OF ZINC (Zn. Cl₂) REQUIRED FOR EACH TUB FOOT, FOR SOFT DA. TANK. THE MEAN AREA OF WHICH IS 677 SQ. FT.

(C. & N.W. R.R. CO., ESCANABA)
AREA OF TUB (A), 677 SQ.
WEIGHT OF SOL. (S), 634 CUB. FT.
% OF SOL. IN TUB (C),

TOTAL % PURE (C₁C) REQUIRED
STP. CONC. SAL. (307060%) (G)
WT. PER. CUB. FT. " (T)
CUB. FT. PER TUB FT. REQ'D (N)
THEN.

= 5% STRONG
cu. ft. per cu. ft.
= 50°/8
= 50°
= 50°
= 50°
= 50°
= 50°

$$\frac{2 \times 3 \times C}{S \times T} = X.$$

FOR ANY OTHER VALUE
OF 2, SAY 3,
THEN.

$$\frac{2}{3} \times X = X'.$$

X.X.t.—LBS. REQ. FOR
SAME CHARGE.

CHICAGO AUG. 30/905. 4 1/2%
5%.

	STRENGTH OF CONCENTRATED SOLUTION	STRENGTH VAT.
% STRONG	3.076	2.600
cu. ft. per cu. ft.	18.458	15.602
= 50°/8	22.156	18.654
= 50°	2.288	1.922
= 50°	11.851	10.900
= 50°	15.950	13.826
= 50°	18.206	16.861
= 50°	17.777	16.666
= 50°	18.752	16.667
= 50°	21.727	18.884
= 50°	25.038	21.727
= 50°	27.303	25.702
= 50°	29.504	29.000
= 50°	29.585	25.976
= 50°	31.861	27.653
= 50°	31.844	27.653
= 50°	34.187	25.961
= 50°	36.412	31.603
= 50°	38.640	33.578
= 50°	35.954	30.674
= 50°	34.401	31.667
cu. ft. per cu. ft.	32.007	31.364
cu. ft. per cu. ft.	32.526	31.364
cu. ft. per cu. ft.	31.720	30.350
cu. ft. per cu. ft.	31.720	30.350

THIS IS COMPUTED FOR A WOODEN STAVE TUB, AREA AT. 4 OF WEIGHT BY SUBSTITUTING MEAN AREA OF ANY OTHER SIZE TUB (S). THE TABLE CAN BE COMPUTED IN THE SAME MANNER.

THE TABLE GIVES FOR EACH 5% BETWEEN 30% AND 60% INTERPOLATE FOR INTERMEDIATES.

TO ESTIMATE FOR VERTICAL FEET NEEDED FROM STORE VAT DIVIDE THE TABLE QUANTITY BY THE AREA OF THE STORE VAT WHICH WILL GIVE THE VERTICAL FT. REQUIRED.

SHOULD IT BE DESIRED TO WEIGH IN THE SOLUTION, INSTEAD OF MEASURING IT IN VERTICAL FEET OF THE VAT, MULTIPLY THE CUBIC FT. BY THE CORRESPONDING WEIGHT PER CU. FT. = (X) SEE TABLE C.

FIG. 30—TABLE "B" CUBIC FEET CONCENTRATED SOLUTION REQUIRED PER TUB FOOT.

TABLE - C- WEIGHT OF CONCENTRATED SOLUTION, CHLORIDE OF ZINC (Zn. Cl.) REQUIRED FOR EACH TUB FT. FOR 30' DIA. TANK. THE MEAN AREA OF WHICH IS 677 SQUARE FEET.
C & N.W.R.R. Co. ESCAMABA.

AREA OF TUB (ft) 677 ft ² .	WT. OF SOL. (lb) 62.4 lb/lb.	WEIGHT OF CONCENTRATED SOLUTION					
		30°	35°	40°	45°	50°	55°
% SOL. 50%	165.7 lbs/tub	357	307	268	238	195	178
% SOL. 45%	-	2146	1839	1610	1481	1315	1203
TOTAL PURE AND REFG. (ft)	-	-	-	-	-	-	1075
STR. CONSEN. (50 TO 45%)	12	-	2504	2146	1850	1669	1401
WT. PER. GALLT. - " (s)	2	-	-	2851	2148	1868	1607
GALLT. PER TUB FT. (sq ft)	21	-	-	3219	2769	2104	1972
THEIR:	-	-	-	3577	3064	2685	2484
$\frac{GALLT.}{GALLT.} = Y$ 1.05	-	-	-	-	2357	2026	1871
FOR ANY OTHER VALUE OF A SAY 'A', THEN $\frac{1}{A} \cdot X = X'$	-	-	-	-	-	-	2001
X' = LB'S MEAS. FOR SAME CHARGE.	-	-	-	-	-	-	1788
CHICAGO, AUG. 5 TH 1903	3	-	-	3723	3405	2992	2787
Chair. M. Horne, C. & N.W.R.R. Co.	-	-	-	-	-	-	2001
WEIGHS SOL. PER. CHART.	-	7340	6510	5720	5170	4650	4200

TABLE - C - THIS TABLE GIVES THE NUMBER POUNDS OF STOCK SOLUTION NECESSARY TO STOCK ONE TUB FOOT OF WATER, AND CONTemplates THE USE OF A VAT MOUNTED ON WEIGHING SCALES.

THE SAME EJECTOR USED TO LIFT THE SOLUTION INTO THE TUB WILL FILL AND EMPTY THE VAT, THE SCALE BEAM TIPPING WHEN THE REQUIRED AMOUNT IS PUT IN. FOR AMOUNT OF WATER TOO GREAT FOR VAT TO MEASURE, THE OPERATION CAN BE REPEATED.

FIG. 31—TABLE "C" WEIGHT CONCENTRATED SOLUTION REQUIRED PER TUB FOOT.

NOTES AND EXPLANATIONS.

(a) This, No. 44, is a typical specimen of the Texas Loblolly Pine. The hewn pole ties at Somerville and at Greenville are largely of this character.

(b) No. 55 is short leaf Texas Pine, mostly heart timber, but having what is termed "red heart," a condition in which three or four inches of the timber encircling the heart of the tree has reached a dead and softening condition, in which the spring wood is wasted quite away and the solid layers of the summer wood much impaired. Specifications should and usually do reject timber so affected.

(c) No. 66 is a three-inch section of a New Mexico Mountain Pine, mostly heart timber, which was treated in 1885, the tie being in track over thirteen years and only removed on account of rail wear. At the time it was immersed, it was seemingly as sound and strong as the day it was cut from the tree. It was treated by the Wellhouse process.

(d) No. 32 is cut from the middle of a 38-foot pile, much the same character as No. 44, Loblolly Texas Pine, in which nearly thirty pounds of creosote oil had been injected per cubic foot. Although not immersed for several months after treating, the lighter portions of the oil readily gave place to the water, smearing the surface of the block and floating on the surface of the water.

(e) Nos. 33 and 34 were blocks cut from chord pieces of the Isletta (Atlantic and Pacific Railway) some time after the removal of the bridge, to be replaced by a steel structure, after a service of over twelve years.

The specimens were cut from the end of the chord piece where packed.

This timber was treated after framing and before erecting and was treated by the Wellhouse process.

(f) Nos. 50 and 52 were untreated blocks of southern yellow pine, companion pieces of Nos. 51 and 53, the latter being treated by the Creo-resin process as paving blocks. The same effect of the absorption of the water as in the case of No. 32 (d) the creosote oil and also the resins being forced out during the process. The difference in the specific gravity is probably the measure of the percentage of creosote oil and resin injected into the wood and the difference in the amount of moisture in the blocks at the time of immersion is a means for guessing the amount forced out by the water, although not all, as the surface of the blocks were well smeared over with the exuded resin to such an extent as to render it mere guesswork.

(g) The anomaly of the greater weight of the sap timber over that of heart timber in case of Nos. 36 and 27, is accounted for by the superabundance of resins in No. 27.

(h) Nos. 54 and 55 are specimen blocks of dead pine supposed to have been killed by a peculiar disease or insect. The timber seems strong and sound, but largely discolored, the discoloration being greatest at the outside next the bark and gradually decreasing toward the heart, leaving the latter in some cases perfectly sound. In transverse strength it seems to be unimpaired but under compression lengthwise, its strength is 20 to 30 per cent less than live, sound timber.

Seri No.	Kind of Timber where from	Hard wood	Weight per cu. ft. in air	Specific heat	Absorption in %								Per cent loss in 30 days		
					3. Young hours	6. Young hours	72. Young hours	7. Young hours	7. Young hours	7. Young hours	7. Young hours	7. Young hours			
06.	Shortleaf Pine	Hl.	.363	.29.26	.630	.010	.659	.063	.109	......	.193	.220	.241	.249	
11.	Longleaf Pine	"	.32.1	.34.70	.566	.081	.055	.086	.079	......	.166	.284	.249	.292	
2.2.	S. L. Pine	"	.36.0	.32.49	.520	.012	.031	.034	.037	......	.119	.665	.215	.248	
33.	"	"	.283	.38.65	.490	.010	.020	.058	.035	......	.135	.174	.203	.233	
44.	"	"	.647	.47.59	.490	......	......	......	......	......	.144	.242	.698	.626	
55.	"	"	.32.0	.24.69	.534	.013	.053	.063	.07	......	.12.2	.263	.32.7	.371	
66.	N. M. Pine (C)	Los Vegas.	Hl.	.25.6	.27.64	.443	.016	.049	.059	.087	......	.157	.2.2	.26.8	.31.6
71.	White Pine.	C. M. N. Mex.	Hl.	.19.6	.21.95	.34.0	H.	... ...	.048	.068	.069	.18.0	.24.6	.46.3	.26.4
24.	"	Guadalupe Red.	Hl.	.26.67	.26.67	.41.2	H.	... ...	.144	.176	.21.9	.29.1	.33.7	.35.6	......
33.	"	Cedar.	Hl.	.20.4	.22.84	.35.4	H.	... ...	.065	.081	.11.3	.18.1	.22.4	.27.4	......
47.	"	"	Spn.	.16.6	.17.96	.28.8	H.	... ...	.061	.077	.11.2	.17.6	.21.9	.26.3	......
55.	Norway Pine.	"	Hl.	.22.2	.25.11	.49.3	H.	... ...	.034	.060	.094	.17.2	.21.6	.23.6	......
66.	"	"	Spn.	.22.5	.32.07	.56.8	H.	... ...	.117	.16.1	.20.9	.22.8	......	.25.9	......
77.	White Oak.	"	Hl.	.41.9	.45.37	.72.6	.02.0	......	.03.9	.06.1	.09.2	.13.6	.17.6	.22.9	......
81.	"	"	Spn.	.43.3	.46.78	.76.1	H.	... ...	.05.0	.07.7	.11.3	.16.3	.18.6	.27.0	......
99.	Tamarack.	"	Hl.	.32.3	.35.90	.65.6	.08.6	......	.02.9	.04.2	.06.6	.17.6	.22.6	.25.6	......
10.	"	"	Spn.	.32.62	.38.07	.62.7	H.	... ...	.02.1	.04.7	.08.2	.13.3	.16.8	.20.6	......
11.	Douglas Fir.	"	Hl.	.30.4	.32.85	.62.7	H.	... ...	.04.0	.06.7	.09.0	.12.0	.17.6	.22.8	......
12.	"	"	Spn.	.30.9	.32.89	.62.6	H.	... ...	.04.8	.06.5	.09.2	.14.7	.19.2	.24.1	......
13.	Hemlock.	"	Hl.	.24.7	.26.72	.42.9	.09.5	......	.05.3	.07.2	.12.1	.18.3	.26.5	.32.4	.37.6
14.	"	"	Spn.	.22.8	.24.50	.39.5	H.	... ...	.09.2	.11.8	.16.1	.22.2	.26.0	.27.3	......
15.	Red Oak.	GMA SIR Rm.	Hl.	.31.8	.33.31	.65.0	H.	... ...	... ...	.03.9	.06.1	.07.7	.13.6	.17.4	.19.4
16.	"	J.W. Barr Mfg.	Hl.	.30.7	.33.17	.53.2	H.	... ...	.05.4	.07.5	.10.1	.13.1	.14.3	.14.3	......
17.	Nicker S. S.	"	Hl.	.45.55	.49.45	.78.5	H.	... ...	.05.8	.07.8	.10.1	.12.4	.12.7	.13.7	......

FIG. 42—ABSORBENT PROPERTIES OF TIMBER. (A)

FIG. 48.—ABSORBENT PROPERTIES OF TIMBER. (B)

Sar.	No.	Kind of Timber	Where from	Heart or sap.	Height... in ft.	Per cu ft. 750 lb.	Spes at Com. Yard	Miles at Com. Yard	Absorption in Vol. -						Over full at 30d. (in.)	
									3 Hours	6 Hours	24 Hours	72 Hours	7 days	14 days		
12.	Mahogany &c.	C.M. & S.P.M.	399	42.36	69/	N.	.....	.....	.056	.082	.112	.172	.190	.....	.....
13.	Sugar Maple.	J.W. Bern M.	407	4.93	70/	N.	.....	.....	.096	.113	.166	.223	.232	.....	.....
20.	B7. Mills Pine.	Dur. & Ad. Co.	45.	2.76	1.97	N.	.....	.....	.063	.071	.043	.264	.267	.....	.....
21.	"	C.W. Shadwell	46.	2.45	1.49	N.	.....	.....	.072	.132	.161	.279	.285	.....	.....
22.	"	"	47.	2.52	2.74	4.37	N.	.....	.....	.093	.126	.156	.244	.264	.....	.....
23.	"	"	48.	2.66	25.74	4.61	N.	.....	.....	.097	.195	.189	.220	.265	.....	.....
24.	Monkish Pine.	Clarke & M.	607	2.27	26.45	3.93	N.	.....	.....	.141	.179	.184	.264	.278	.....	.....
25.	A7.55' Rg.	"	49.	2.55	27.67	4.91	N.	.....	.....	.073	.112	.143	.183	.219	.....	.....
26.	Green Pine.	Maxwell Gr.	50.	2.41	25.62	4.17	N.	.....	.....	.079	.124	.167	.192	.239	.....	.....
27.	"	" (8)	50.	3.57	32.83	6.07	N.	.....	.....	.121	.189	.224	.244	.277	.....	.....
28.	"	"	51.	2.87	23.67	4.97	N.	.....	.....	.083	.116	.143	.176	.217	.....	.....
29.	"	"	52.	2.81	28.49	4.91	N.	.....	.....	.062	.099	.141	.161	.204	.....	.....
30.	"	"	53.	2.25	29.26	3.19	N.	.....	.....	.082	.109	.115	.130	.164	.....	.....
31.	Spurce.	M.M.	54.	2.90	31.20	5.22	N.	.....	.....	.048	.097	.118	.164	.224	.....	.....
32.	S4.2 Lang Pine	Sammons & Co.	55.	3.61	31.45	6.77	4.9	.....	.....	.219	.264	.271	.304	.364	.....	.....
33.	White Pine (6)	Seal Marsh Co.	56.	2.35	25.35	4.47	N.	.....	.....	.055	.091	.133	.....	.210	.....	.....
34.	"	" (a)	57.	2.19	26.71	2.96	N.	.....	.....	.059	.095	.136	.....	.272	.....	.....
35.	Red Spruce.	C.G. Minot & Co.	58.	2.60	28.42	4.87	N.	.017	.....	.054	.....	.069	.221	.274	.....	.....
36.	"	Ry. C.H. Dated	59.	2.72	29.34	4.71	N.	.013	.....	.054	.....	.043	.197	.243	.....	.....
37.	Ponder. Pine.	"	60.	2.30	29.11	3.99	N.	.051	.....	.053	.....	.259	.268	.278	.....	.....
38.	Colorado Pine.	"	61.	1.96	21.22	3.90	0.67	.....	.....	.079	.....	.196	.223	.269	.....	.....
39.	White Pine.	"	62.	2.17	23.42	2.74	N.	.063	.....	.103	.....	.178	.241	.327	.....	.....
40.	Green.	"	63.	21.92	4.40	N.	.046	.....	.077	.....	.163	.195	.268	.293	.....	.....
41.	White Pine.	Gofford & Co.	64.	24.3	26.21	4.70	0.77	0.35	0.87	0.85	0.85	0.85	0.85	0.85	2.51	.....

(C)

ABSORBENT PROPERTIES OF TIMBERS—WEIGHT &c.

No.	Kind of Timber	Name from spec.	Heart Weight in lbs. per cu ft.	Stem Weight in lbs. per cu ft.	Height in ft.	Spec. width in in.	Spec. height in in.	Grain Ch.	Absorp. tion in hrs.	Absorption in hrs.			Over all abs. % Journ. abs.
										3 hours	6 hours	72 hours	
42. Norway Pine, Gum	Gum	"	2.87	2.55	410	.005	.043	.053	.040	11.5	11.5	11.5	.222
43. Tamarack	"	"	2.94	37.71	377	.021	.023	.028	.044	.071	.117	.184	.233
44. White Cedar,	"	"	2.60	2.63	347	.012	.041	.049	.072	.098	.134	.192	.267
45. Arizona Pine, Santa Fe, N.M.	"	"	2.42	26.77	426	.005	.041	.048	.072	.116	.149	.181	.199
46. Oregon Pine, Kingsport,	"	"	2.62	27.79	434	.015	.013	.054	.084	.121	.154	.192	.212
47. Yellow Mahogany, Tulsa, Okla.	"	"	2.48	26.79	423	.013	.057	.069	.088	.117	.161	.216	—
48. Tamarack,	G. N. Ry.	"	2.73	29.43	474	.036	.036	.067	.080	.114	.140	.186	.230
49. Douglas Fir, Santa Fe, N.M.	"	"	2.49	26.92	432	N.	.046	.054	.078	.115	.159	.210	—
50. Sis. Yellow P.	Gregorian Ht.	"	4.28	46.15	791	.007	—	—	—	.074	.102	.159	.269
51. " "	Theother. (33)	"	6.48	65.25	732	.019	—	—	—	.077	.081	.099	.111
52. " "	Map.	"	3.54	35.23	643	.032	—	—	—	.073	.096	.134	.134
53. " "	Treasad.	"	5.80	72.65	666	.074	—	—	—	.101	.115	.131	.175
54. Dead Pine (4)	Blackwillow, Ga.	"	2.92	31.57	676	.059	—	—	—	.162	—	—	.278
55. " " ("")	"	"	2.23	61.73	317	.036	—	—	—	.095	—	—	.303
56. Live "	"	"	3.16	34.65	544	.269	—	—	—	.061	—	—	.369
57. Sweet Gum	Texas.	"	—	—	—	—	—	—	—	—	—	—	—
Chicago Aug. 7th 1901													#7 is column for commercial.
John. W. Hurd													
Fig. 44—ABSORBENT PROPERTIES OF TIMBER. (C)													

FIG. 46.—ABSORBENT PROPERTIES OF TIMBER. (D) FOR "E" SEE PAGE 181.

No.	Kind of timber	Wherefrom	Weight per cu. ft. 265 Ozs	Spec. weight at com.	Molst at Grav. 265 Ozs	Absorption in %62.	(D.) *						
							3 HRS	6 HRS	24 HRS	7 Days	14 Days	30 Days	60 Days
57	SWEET GUM	MONTGOMERY Co.	.364	.32.8	.527	.113		.104	.164	.202	.219	.254	.285
58	BEECH	INDIANA	.358	.36.7	.621	.067		.081	.117	.143	.173	.214	.248
59	MT. PINE (a)	NEW MEX.	.260	.28.0	.450	.021		.329	.581	.899	.422	.463	.503
60	" " (b)	" "	.266	.28.7	.461	.020		.321	.373	.402	.435	.469	.512
63	BLACK OAK	LUS. CHANNEL	.384	.41.4	.665	.149		.058	.080	.098	.122	.157	.199
64	RED	" "	.427	.46.1	.738	.133		.070	.094	.123	.155	.196	.219
65	WATER	" "	.435	.46.9	.754	.198		.053	.068	.087	.126	.132	.151
66	COTTONWOOD	MONTANA	.228	.24.6	.394	.049		.189	.295	.331	.343	.389	.426
67	WHITE SPR.	BY J. O'BRIEN	.1926	.20.8	.334	.023		.085	.125	.146	.186	.250	.265
68	TAMARACK	" "	.241	.26.0	.470	.035		.063	.110	.141	.195	.211	.215
69	BULL PINE	" "	.2451	.26.5	.4247	.035		.074	.106	.128	.167	.220	.247
70	TAMARACK	" "	.2931	.31.65	.5079	.076		.050	.082	.130	.181	.233	.254
71	Douglas Fir	" "	.2910	.31.43	.5049	.049		.057	.080	.115	.174	.219	.234
72	" "	" "	.2712	.29.29	.4700	.047		.066	.095	.119	.179	.226	.231
73	Yellow Pine	NEW MEX.	.2394	.25.86	.4148	.022		.110	.295	.317	.337	.360	.414
74	White S. S. HOPPEN	"	.2505	.27.45	.4341	.081		.069	.103	.123	.154	.195	.251
75	BALSAM FIR	"	.2354	.25.42	.4077	.110		.099	.148	.169	.197	.227	.264
76	RIO SPRUCE	"	.3015	.33.21	.5328	.026		.043	.066	.088	.123	.164	.197
	MEAN %,		.290	.31.6	.503			.106	.155	.181	.217	.256	.285
	MEAN RATIO,							.372	.472	.501	.127	.162	.192

ABSORPTIVE POWERS OF TIMBER.

A wide range of experience in treating timber for the purpose of preservation from decay, or at least for prolongation of its life by resistance of decay, has taught that the physical structure and condition of the timber is important in connection therewith.

It is in view of this that the investigations embodied in the tables (A) (B) and (C), are compiled. Much expense and labor has attended this work, prolonged as it has been through several consecutive years. Much valuable assistance has been rendered by various civil engineers and, as the work will be and is now being continued, further interest is invited for which due credit will be given. Without question, much can be learned in this way that is important to the operator of works now and to be engaged in the timber treating business, by a careful study of this matter. It will aid the judgment of the operator in adapting the process to the character of the timber coming to him and result in an economy of both time and expense.

EXPLANATION OF METHOD.

For the test of absorptive powers of the timber by immersion, the timber is procured cut to length as nearly as practicable, four inches, so as to present the best possible condition for the action of the capillaries. The blocks are first dried to nominal dryness, that is, to such degree of dryness that the wood will absorb or give off the moisture of the atmosphere successively as the air changes. When this is not practicable, the specimen is dried to this condition after it has gone through the immersion and the moisture at the initial time is determined and added to the absorption as shown as the total at thirty days. The thirty-day column is the quantities for comparison. The samples are weighed, the initial weight being noted, then immersed in pure Lake Michigan water and securely weighted down and there kept continuously except during the brief time used in weighing

at intermediate times until the thirty days have expired. The volume of the block is determined by measurements and by the further check of weight in water at the close of the test. The unit weight of water is taken for 65 to 70 deg. Fahr., being the uniform temperature of the laboratory, at .5771 oz. per cu. inch or 62.327 lbs. per cu. foot.

OBSERVATIONS.

It is not the purpose here in the limited condition of these investigations to go into an analysis of results in an extended way, and only such points as bring out the principles hinted at as are most noticeable as relates to their application to the treatment of timber.

Perhaps no way will better illustrate the effectiveness of the modern plant than a comparison of the results attained with these thirty-day tests with the ordinary one and a half or two hours exposure of the timber to the impregnating solution in the retort. In the one case a block four inches long, exposing all the natural sap ducts of the timber directly to the entrance of the water in the first case, whereas in the latter case the timber never less than eight feet long lacks this facility in a high degree, yet it absorbs more in that brief space of time, and an amount in volume at least 75 per cent of the total voids of the timber. In this connection it must be remembered that during the process of steaming that a considerable amount of the condensed steam remains in the timber after the vacuum is drawn and before the solution is introduced, and it is altogether probable that this with the solution absorbed, fully occupies every bit of the voids of the timber so that to put in more would be a physical impossibility. A comparison of these results at thirty days corresponds very nearly with the absorption obtained with the same timber at the various treating works now in operation, and it is believed to be of sufficient value to offer to those interested.

THE THREE-MOVEMENT PROCESS.

The Wellhouse process as taught and practiced in 1885 consisted of two applications, one of the chloride of zinc (one and one-half per cent strong) with the gelatine (one-half per cent) incorporated with the chloride. This was applied to the timber in the retort under 100 pounds hydraulic pressure for two and a half hours. Following the chloride, the tannin solution (one-half of one per cent strong) was applied under like pressure and conditions. No provisions were made to increase the temperature of these solutions above what was acquired by contact with the hot timber in the retort.

Under these conditions, with a one and one-half per cent solution, the Rocky Mountain pine absorbed from one-quarter to one-half pound of pure chloride per cubic foot, the former for sawed heart pine and the latter for hewn pole ties. This practice was introduced by Wellhouse and Mr. Joseph P. Card, M. Am. Soc. C. E., at that time associated with Mr. Wellhouse, at the time that the Las Vegas Timber Preserving Works were installed, and has been followed, with slight exception, in all the work at those works. The results are perhaps as well determined and definite as in case of any known process and practice and perhaps the most satisfactory in results of any except the more expensive process by creosote oil.

To distinguish this practice from others consisting mainly of a modification of this, we will call this the "two-movement" process.

There are several modifications suggested by subsequent experience, among which are:

1st. Application of the gelatine in a separate solution, thus requiring another movement, hence the designation "three-movement."

2d. The application of much higher temperature to the various solutions.

3d. The increase of the strength of the chloride solution used to the end that a greater quantity of the chemical be injected.

Practically, these three points cover those of greatest moment at this time, and we will take them up in the order given.

The grounds upon which the three-movement practice is advocated is that with the gelatine added to the chloride solution, the former being of a viscous nature, retards the ingress of the chloride and renders it difficult to get enough into the timber.

It is true of the gelatine that it is impossible to reduce it to such consistency as that it will penetrate the solid parts of the wood. It can never be reduced to a true solution so that it will be carried into the wood by the water in which it is dissolved, and the greatest possible penetration is where it follows the more or less open ducts of the wood, or cracks and checks that result in or during the drying of the timber. The addition of chemicals to cut or render the gelatine as fluid as possible, or the application of a high degree of temperature, are the agents that will induce the greatest penetration. If the gelatine is used in simple solution, the heat is the agent most effective, and without the heat the glue will spread on the surface of the timber like a coat of grease or paint, and very slightly penetrating the pores or checks of the timber. It is equally true that when the gelatine is incorporated with the chloride, that the latter helps to hold in solution. It also follows, that the large volume of the chloride solution absorbed (about ten times that of either that of the gelatine or tannin when applied alone), that the glue would be more thoroughly introduced in the surface of the timber than is possible if applied separately.

It is claimed to be possible, too, that if introduced incorporated with the chloride, that a portion of the gelatine will penetrate beyond where it will be reached by the tannic acid, and therefore it will be left in the wood as a seed for decay on account of its extreme perishable nature. When the tannic acid is pure it is as thin as water and is a solvent in the true sense, and will penetrate as far as the water goes. Then if we cipher a little, using every day experience as to

the amount of the tannin solution that must enter the timber under the 100 pounds pressure, we find that the timber must be penetrated nearly one inch over its whole surface; more where pores and checks offer free access and less where solid and compact wood prevents.

The fact that the high results were attained under the process as initiated by Mr. Wellhouse himself, and the further fact that by proper means applied, almost any desired quantity of the chloride can be injected under the two-movement process, and in less time for the whole treatment of a charge of timber, would seem to be a sufficient answer.

NOTE.—Since the foregoing notes were written the writer has had some experiences with timbers of the Pacific slope. The fir and the tamarack, especially the latter, is impregnated with difficulty, the volume of absorption being meager as compared to the western and southern pines, hence if high amount of chloride is desired, unusual means must be resorted to. While it has not yet been satisfactorily proven that the glue does reduce the amount of absorption of the chloride, yet in view of this possibility, the separate application of the glue may be justifiable. With these exceptions there is not sufficient reason to prolong the process for the separate application of the glue.

— A careful test at Greenville, Tex., showed no appreciable retardation of the absorption of the chloride by the presence of the glue in the chloride solution. This is true wherever the open grained timber is treated, notably the pines of Texas, Colorado and New and Old Mexico.

INCREASE OF STRENGTH OF SOLUTION.

We have seen that heart timber with one-quarter pound of the chloride per cubic foot of timber when in the shape of a 6 in. x 8 in. sawed tie, resulted in a measurably sound tie after it had become useless from rail wear. We may therefore conclude that a less amount would have served equally well. Then we find that the pole tie, mostly sap, having one-third of a pound, has its usefulness prolonged from two to three times the life of an untreated tie of the same character.

Then why increase the cost of the chloride fifty per cent simply to make sure to get in enough?

Let us examine the philosophy of the process. It consists of three essential parts or effects. First, the steaming, then the impregnation and lastly the plugging up of the outer part of the timber by which the antiseptic introduced is protected from waste. The first frees the timber from those juices that cause the inception of decay and which feed it after it has commenced, the second introduces the antiseptic properties which, while present in the timber, effectually prevent decay, and the third aids in retaining and preventing waste of the preserving properties.

Not all, by any means, depends upon the antiseptic. The steaming must be prolonged sufficiently to allow the heat to reach the center of the piece, but if this is not done, there will be a section at the center of the tie in which the objectionable juices of the timber will remain and which the antiseptic, when introduced, both by the steam and by the antiseptic must be had, otherwise the work is imperfectly done. The permeation by the steam is the paramount result to be secured and even should the amount of the antiseptic be reduced by oversteaming, yet, its permeation is more complete and a little less well distributed, is better than much more confined to the outer portions of the piece. While a stronger solution may put in

the desired pounds, yet such practice cannot be characterized except as waste.

Fifty per cent increase in the amount of chloride can be figured and amounts to a sum that it is not cared to name, and if it is unnecessary, would not be justified by anything but "speculative reasons," which would hardly pass with business men.

GREATER AMOUNT OF HEAT.

As before stated, little attention was paid to the temperature of the two solutions then used. Later investigations by experienced observers have strongly impressed the conviction that heat is a very active element, not only in its application to the charge in the shape of steam by which the saps of the wood are dissolved and expelled and the timber prepared for the free ingress of the solutions, but in the shape of increased temperature to the various solutions as creating more favorable conditions for the desired and necessary chemical actions. In using the two-movement process the heating of the chloride solution is important from the fact that with it is carried the gelatine to which high degree of temperature is necessary for best results. Where the gelatine solution is used simple, high temperature is *absolutely necessary*. With the two-movement process the temperature of the chloride solution keeps measurably high from the heat derived from the steamed timber, hence less heating appliances are necessary. The tannin solution requires some heat to promote its chemical combination with the gelatine though not so great a degree but its temperature should be controlled as well as that of the others.

The improved heating coil for the solution tank shown on page 25 and the retort coil, page 118, enables the operator to fully control the temperature so that 150° to 180° F. can be secured, and the retort coil will bring the creosote oil to the boiling point, at 190° to 200° F.

DOES CHEMICAL TREATMENT OF TIES INCREASE
THE HARDNESS OF THE WOOD AND THE
HOLDING POWER OF THE SPIKE?

J. H. MCNEIL, R. M., SOUTHERN CALIFORNIA R. R.

Report of a committee presented before the 19th annual
convention of the Roadmasters' and Maintenance
of Way Association, Washington, D. C.,

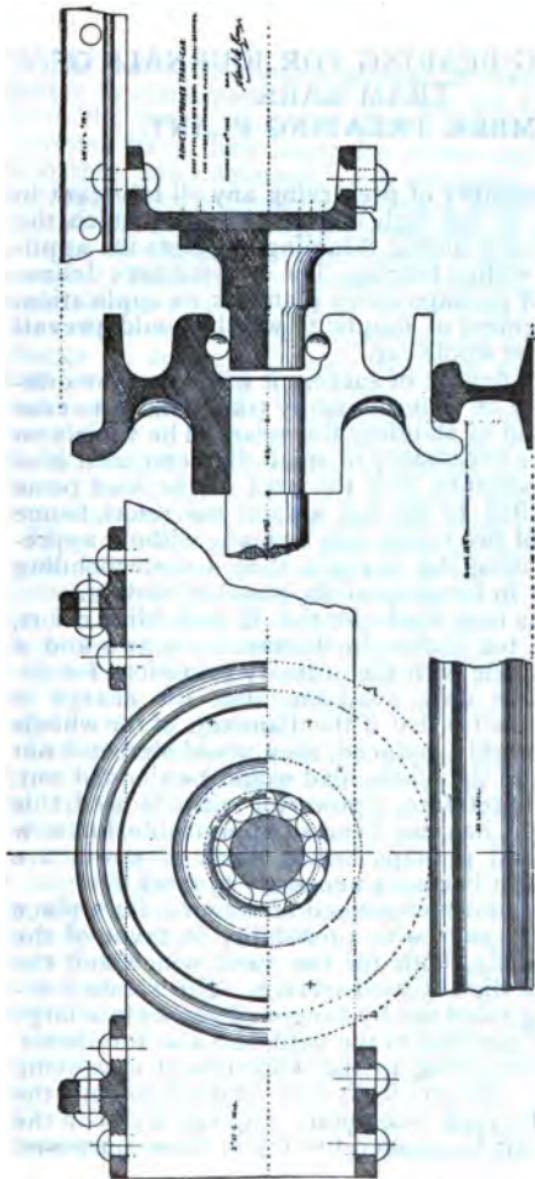
Oct. 8-10, 1901.

This paper refers only to the zinc-tannin or Wellhouse process of timber preservation, and the committee to whom the subject has been assigned, has made several tests with the treated ties available, and has received the written opinions of persons in different parts of the country who have had experience in the treatment and use of treated timber.

The consensus of opinion, supported by the tests made by your committee, is that treatment does not increase the hardness of the wood, but does increase its density and transverse crushing strength in proportion to the amount of treating material absorbed. But, while the timber is not hardened by the treatment, it is made more flexible and tough, and will, by reason of the increased density of the wood and action of the chemicals used, prevent the rail from cutting into the ties, in proportion to the amount of preservative absorbed, or about 30 per cent in coarse grained pine.

Common mountain pine, such as is found in New Mexico and Arizona, now largely used as tie timber on western lines, is an open grained, coarse wood, and absorbs, when treated, about 30 per cent of the preservative. Close grained, firm timber absorbs less of the chemicals than does the open grained soft wood, and is, therefore, proportionately less affected by the treatment.

We find that the spikes, when driven, damage the fiber of the timber less in treated than in untreated timber. The holding power of the spike is not noticeably increased at the time the tie is treated, but increases as the timber dries out, until at the end of from six to nine months, when the timber has become seasoned, a pine tie which has absorbed the usual amount of chloride of zinc, tannin and glue, will have increased the holding power of the track spikes not less than 20 per cent.



ROLLING BEARING FOR TRAM CAR AXLE.

For Timber Preserving Plant.

This wheel and box are intended for a car with 35% clearance between channels. The balls are introduced before attaching box to channel beam, the balls being held in place by filling the travel way in the wheel with a little tallow while the spindle is introduced. For other sizes and make of car, the length of axle can be varied.

ROLLING BEARING FOR JOURNALS OF TRAM CARS. TIMBER TREATING PLANT.

The impossibility of preserving any oil lubricant in consequence of the high degree of heat to which the cars are exposed during steaming, suggests the application of the rolling bearing. The drawing here delineated is one of perhaps many plans for its application. It has the element of simplicity which should prevail throughout the whole car.

With what degree of success it will cover the difficulty can only be determined by trial, both as to ease of draught and of standing the wear. The wheels on these cars are necessarily of small diameter, as it is of the first importance that the area of the load be as near as possible to the full area of the retort, hence a reduction of two inches can be made without appreciably increasing the draught, then a corresponding gain is made in increase of the possible loading.

The cars as now made for the 72 inch (dia.) retort, have wheels ten inches in diameter and two and a quarter inch axle with the ordinary provisions for oiling, which are only available after the charge is drawn. The fact is that if the diameters of the wheels were considerably reduced, they would sled and not turn at all, and the whole load would be sledded out.

When, as heretofore, a powerful wince is used, this heavy draught has not been so appreciable, but now that other and perhaps better kinds of power are being sought, it becomes necessary to meet it.

Electricity and compressed air now vie for a place or means of power with probability in favor of the latter eventually, both for the yard wince and the locomotor for distant yard service. The steam locomotive being ruled out by danger of sparks in a large collection of material in the yard, and also for operating the wince owing to the difficulty of conveying steam so far. Electricity is well adapted to both the wince and the yard locomotor. Equally well can the compressed air be applied to each of these purposes.

While the latter is more prompt in responding and better in consequence for moving the charge to or from the retort than the electric motor, the two in common have their limitation in the amount of traction they can command. For charging or discharging, the wince is transcendently the best adapted, as this should be done with the greatest care or otherwise serious damage may result to the retort and attachments. The charge including the tram cars will weigh more than the empty retort, hence if the engineer of the motor is obliged to make a run to get his charge in, serious damage is almost sure to result first or last. With the wince a stop within a few inches is practicable. It is claimed by the manufacturer of the air motor that their locomotors are equally under control. As regards the electric motor it is not. In any case, a remedy for the heavy draught of the tram train is being called for and must be provided.

The relative merits and cost of installation of these two means of power are as yet unsettled but probably will be settled in the near future, as each has its advocates; and really the best method, and about the only one, will be that of results after trying. It appears, however, at this time that the compressed air is both the best adapted and the cheapest to install and to operate.

The compressed air motor seems the best in the respect that its installment can all be placed in the ground, its feeding points so located as to always be in easy reach when the motor needs to recharge, and the motor is free to go quickly to any part of the yard as needed, whereas the electric motor can only operate where the tracks are wired. For the wince, the electric power is an ideal one as is also the compressed air. One difficulty in using the compressed air is that the high power necessary to operate the locomotor is unsuited to operate the wince, or so at least was apprehended, but later this has been overcome by using the compressor that is used to move the solutions.

The C., B. & Q. R. R., at their works at Sheridan, Wyoming, are now doing this quite successfully, thus

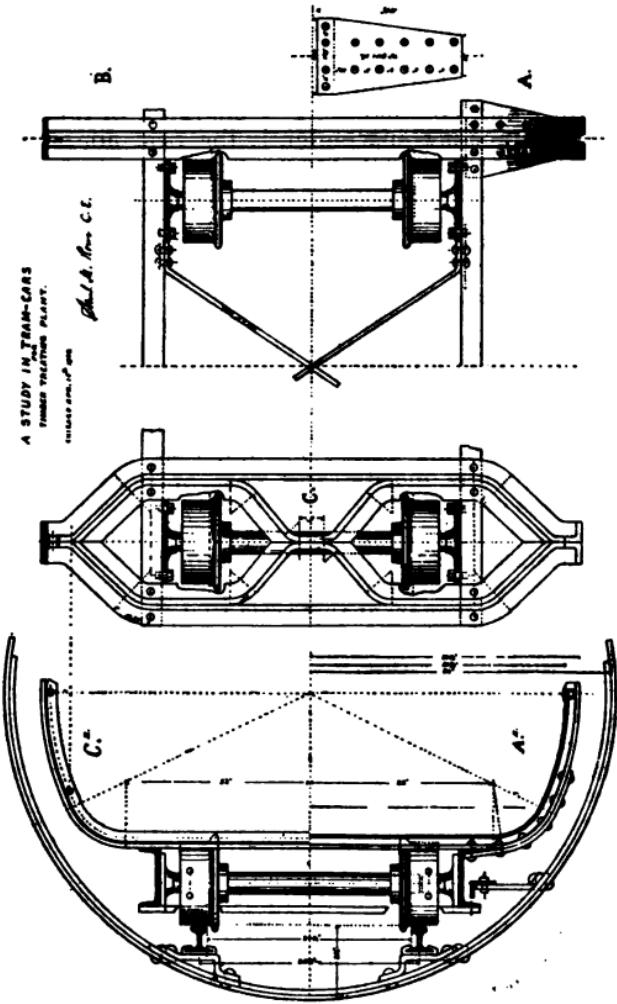


FIG. 65.—A STUDY IN TRAM CARS.

doing away with the necessity of a special engine for the lower pressure.

THE PROPER PROPORTION FOR THE RETORT.

In the first place the diameter of the retort should be such as to receive the car of the most convenient dimensions for loading and unloading. The most common diameter is that of even six feet which receives a car the load of which will be near six feet from ground level, which is about as high as men can load economically. The cars best adapted to this service must be as light as practicable and strong, above all, strong, and as simple in construction as possible. In proportioning the car all these requisites must balance as nearly as possible.

Any effort to strengthen by increase of weight is likely to defeat its purpose, as in use these cars receive much harsh handling that is made still more destructive from the added weight.

The door for sealing the retort would have to be stronger in all its parts if the diameter is enlarged, and the door, if self sealing, is quite an important part of the cost, and when adapted to one dimension, and that the most suitable, any change is to be deprecated.

Much has been said in favor of the bolted door, but a little observation must satisfy the observer of the superiority of the "Spider Door," both for economy of time and labor.

A retort of this diameter is amply strong to stand the service, both for the necessary pressure and for its stability in form.

The length can be made to suit the conditions or fancy, but should not exceed 120 feet and may be anything down to 40 feet.

SHOULD TRAM CARS HAVE COUPLING?

While recognizing the necessity of keeping up with the times, the fact that the tram cars have heretofore been handled without difficulty without the coupling appliances, there seems to prevail an impression abroad that the omission of these appliances is a grave one. Why?

The only seeming result where couplings have been provided, is that their use is neglected and a lot of surplus chains are around in the way. The fact that the cars with loads or without can be pushed ahead with any power, or can be drawn by means of a suitable cable, even to the charging and discharging of the retort, seems to point to lack of any necessity for them.

The provision of light cables of about the length of the retort, any train of loads or of empties can be hauled safely by the motor over any part of the yard. The same is true with any lesser number of cars.

Perhaps ninety-nine per cent of the labor in connection with the plant is in handling the material, including the handling of the tram cars in placing them; dangerous enough in itself to hands and limbs and the additional risk in coupling should not be incurred without better reasons than now appear. The extra expense of the couplings cannot be neglected as it is considerable, saying nothing of the time required in coupling a loaded train, which at best is a troublesome and a dangerous operation. "A word to the wise, etc."

THE TIE LOADER. INTRODUCING A LABOR SAVING APPLIANCE.

The most severe labor connected with the operation of a timber preserving plant is the unloading of the treated ties into box cars.

For economic reasons a large part of the output is thus delivered, and the fact being that these freshly treated ties have from fifty to seventy-five per cent of

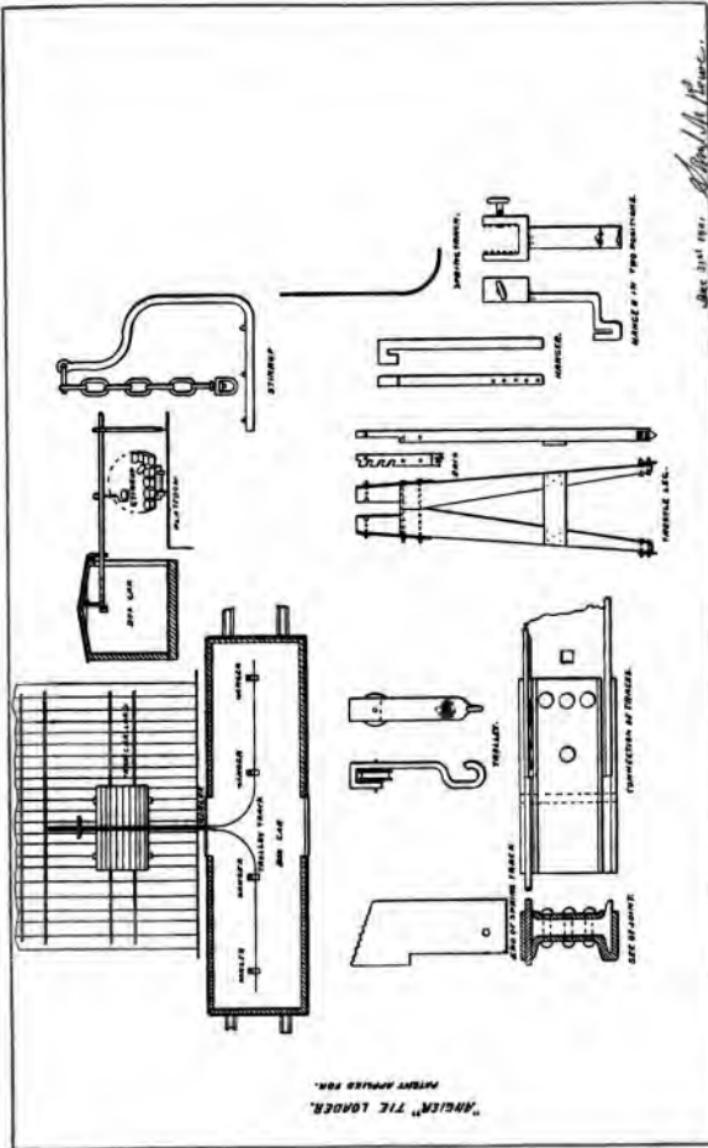


FIG. 57.—ANGIER TIE LOADER.

weight added to the normal weight, renders them very heavy, requiring from two to three men to lift and carry them into the car. For two men the labor is so severe that it requires an athlete to stand the labor, and it is very difficult to secure men to do this part of the work. Much delay always results from this difficulty when organizing a force.

The illustration given on the preceding page shows "The Angier Tie Loader" (patent pending), which is now ready to offer to those desiring such an aid. It is claimed that two men will load more ties into a box car than four men can do by hand, and that the labor is brought within the strength of any ordinary workingman.

TABLES FOR CONVENIENCE IN COMPUTATIONS. FOR LABORATORY WORK.

Measures. Cubic feet, (1728 cu. in.). Cubic centimeters, (eq. .0610254 pr. in.).

Weights. (Avoirdupois) lbs. ozs. fractions of oz. to 4 dec. and grains. (7000 grs. to 1 lb. av.) Using ozs. as units generally.

For temperature. Fahrenheit thermometer.

For liquid density. Beaume hydrometer (in gross .0 to 60 deg., and for fine .0 to 5.00 deg., Be.).

TABLE OF OUNCES AND GRAINS IN FRACTIONS OF AN OUNCE.

1 grain equals .0023 ozs.	10 grains equal .0230 ozs.
2 grains equal .0046 "	15 " " .0343 "
3 " " .0068 "	20 " " .0457 "
4 " " .0091 "	25 " " .0571 "
5 " " .0110 "	30 " " .0686 "
6 " " .0137 "	35 " " .0800 "
7 " " .0160 "	40 " " .0914 "
8 " " .0183 "	45 " " .1028 "
9 " " .0206 "	50 " " .1143 "

One oz. av. equals 437 grains. One-half oz. equals 218.75 grains. One-quarter oz. equals 109.4 grains, and one-eighth oz. equals 54.7 grains.

DRAWING A VACUUM.

Computations by Prof. S. W. Robinson, Professor of Mechanical Engineering, Ohio State University, Columbus, Ohio, Nov. 24, 1900:

Answering your letter, I found it to take quite a little study. I assume that your pump has a clearance to be filled at each return stroke as if the piston had a hollow spot, or that a valve required a space, or something, so that at end of return stroke there was this clearance vol. that cannot be rid of; represented by the vol. e. f. on sketch. This is always constant.

These values 4", 3.55, 3.12 and 2.78 are the limit to which your pump lowers the barometer column to, at limit of exhaustion by pump, and are proportioned to the barometric columns at the stations before pumping. That is, the above figures are proportional to 30", 26.62" 23.38" &c., in a given air pump, whatever the air pressure.

It may be the air pressure to lift the weight of valve &c.

Fine physical laboratory air pumps require this valve to be lifted by force automatically.

Now as the piston of your pump lifts, assume first, that the air under it remains constant temp., and that the vacuum is about completed as far as your pump will do it, then, at any stroke or two, the pressure will be, say 30" mercury at sea level where, for now, assume the pump to be. On lifting piston from C. to B., the stroke (O. C. being clearance), the falling pressure with increasing stroke will, for air at constant temperature in pump, describe the curve D., F., G., L., &c., stopping at L., actually, as end of stroke; but if piston kept on, the line would continue as to x.

At 3,500 feet elevation, the curve would be at H. M. At 7,000 feet elevation the curve would be at I., N., or at top of Pike's Peak at 14,500 feet elevation the curve would be at J., O., and so on.

In your letter you speak of the terminal mercury column being 4" shorter or 26" instead of at air pressure, 30"; or really, I suppose the column connected

D I A G R A M.

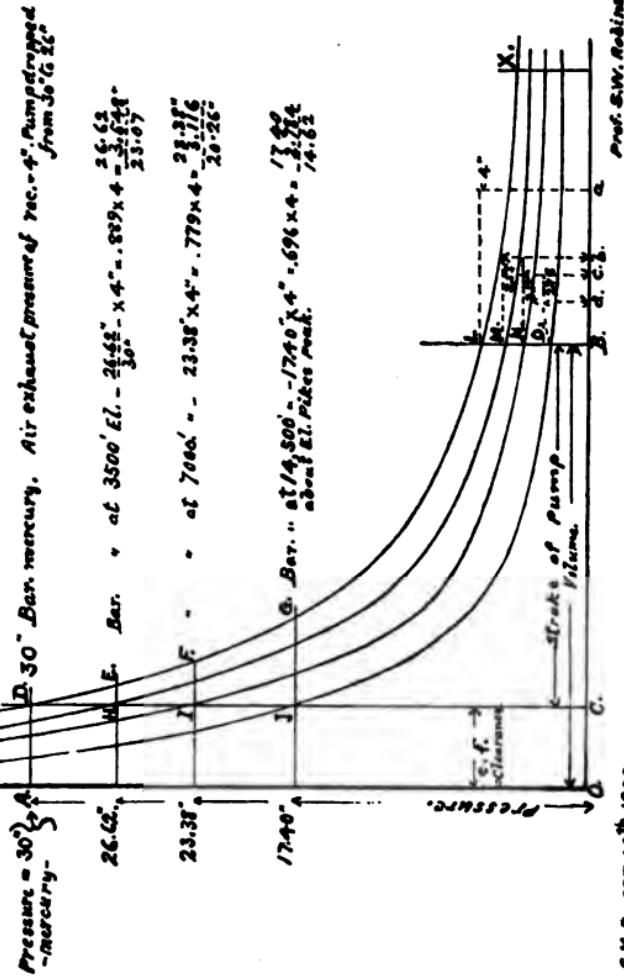


FIG. 59—DIAGRAM VACUUM.

with the clearance side of pump will stand at 4" when the pump has reached its limit. This 4" will be found at L., on the curve when the pump has completed its stroke, or a stroke at finish of pump's practical vacuum.

Now these curves will be equilateral hyperbolæ of air expansion, where equivalent of curve is $xy = \text{constant}$, or say eq. $AD \times CD = xy$. Consequently the values BL, BM, BN, etc., will be proportional to CD, CH, CI, etc., respectively, so that when the barometric heights are 30", 26.62, 23.38, etc., the heights BL, BM, BN, etc., become known. (For sudden or quick pumping, the curve is adiabatic.)

The values, 26.62, 23.38, etc., are to be determined by some barometric formula from the heights such as you gave as 8,500 feet and 7,000 feet elevation. This formula is the well-known Laplace barometric formula you may be familiar with, which is:

$$X. (\text{ft. in el.}) = 60346 (1 + .00256 \cos. 2\phi) \left(1 + \frac{2T + T_1}{1000} \times \log \frac{H}{H_1}\right)$$

T and T_1 are centigrade temperatures at two stations, and H, H_1 , bar. hts., I drop out the (ϕ) whole parenthesis or latitude, term in my calculation here, giving:

$$X. \text{ in feet, } = 60346. \left(1 + \frac{2T + T_1}{1000}\right) \left(\log \frac{H}{H_1}\right)$$

With this data I now arrive at a set of figures thus:

At 200 ft. el. 30	in. mercury tem.	60 deg. Fah.	-16	deg. C.
" 3,500 "	" 26.62 "	" 50 "	" -10 "	"
" 7,000 "	" 23.38 "	" 40 "	" -4.4 "	"
" 14,500 "	" 17.40 "	" 32 "	" -0.0 "	"

Now allowing for the residual mercurial columns, measuring your vacuum, at the different altitudes of 4", 3.35", 3.12" and 2.78", etc., you get

$$\begin{aligned} 30" - 4" &= 26" \\ 26.60 - 3.35 &= 23.07 \\ 23.38 - 2.12 &= 20.26 \\ 17.40 - 2.78 &= 14.62 \end{aligned} \quad \left. \begin{array}{l} \text{As indicating the mercurial} \\ \text{column which represent your} \\ \text{vacuums.} \end{array} \right\}$$

These figures in last column are really exactly the same as you have given in your letter for the highest viz. 26" at sea level, 23" at 3,500 feet elevation and 20" at 7,000 feet elevation. You say 24" to 26", 23" to 21", 18" to 20", as if you readily got the lower values at each place, and that the larger values at each place were the limits. These exactly agree with my results. I used your 4" as from 30" to 26", 4" at lower station. This treated by the diagram gives the other figures.

To go farther with the columns toward the perfect vacuums will require a more perfect pump or one with less clearance. One way with same pump is to have oil or water to stay in pump to fill clearance e. f. at each return of stroke.

PROF. S. W. ROBINSON,
Nov. 24, 1900. O. S. U., Columbus, O.

THE DETERMINATION OF LIFE OF TREATED TIMBER, IN RAILROAD TIES.

The determination of life of timber when exposed as in cross ties or sleepers in a railroad track with any degree of precision is, for several reasons, very difficult. To approach anything near it requires a careful record in detail, which is very difficult to keep for a sufficient length of time as things go. Even if this was done ever so carefully and definite data were secured in one locality, the differences in climate, soils and conditions would give something quite different at another location.

This being the conditions, we will have to be satisfied with an approximation.

The following sketch is intended to show some deductions from the limited records in reach as furnished by the A. T. & S. F. Ry. on the treated mountain pine ties. The percentages as shown by line A. as regards the first eight years, is derived partially from the early periods of subsequent years (after 1896), where number of rotten ties removed have been reported. From 1897 to 1900 we have full record.

FIG. 82—RATE OF RENEWALS. (WEALTHHOUSE PROCESS, A. T. & S. F. B.Y.).

DIAGRAM SHOWING RELATIVE PER CENT OF CROSS-TIES REMOVED.

A. Isodiameters of percent of treated pine ties taken out in amount of string.
 B. Isodiameters of untreated treated pine and C. Is the same for untreated pine.
 Note: The ratio of the untreated pine is obtained from the ratio mentioned
 from the ratio of percent removal of the treated pine and from the per cent
 removal of untreated pine. The diagram is probably a minimum value since
 given here only a few cases are given.

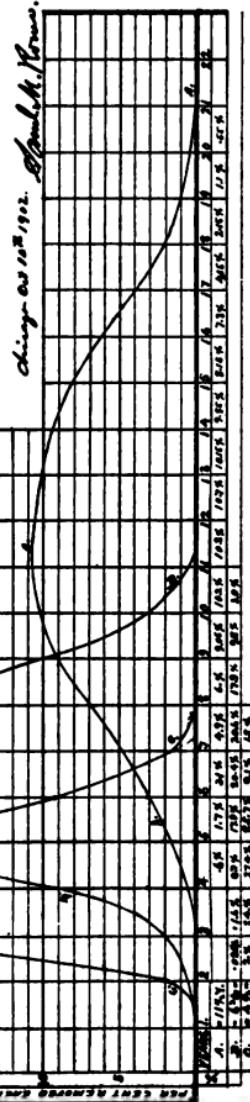


FIG. 58—DIAGRAM SHOWING RELATIVE PER CENT CROSS-TIES REMOVED.

It will be seen here that the mean life is near eleven and one-half years, and that the rate so far as to life is the minimum. We do not know how many ties of each year's treating have been removed previous to the commencement of the record in 1897. Referring to table compiled in October, 1900, compiled on the presumption of twelve years mean life, we find that not nearly so many rotten ties are being removed as should have been. (Only from 50 to 75 per cent.) Should the same be true as to the years from 1885 to 1896, then it is presumed that our line is too high at first and that in the end a year or two more can be added to the mean life here shown for treated ties.

Awaiting the time when the record shall have been completed, we shall have to rest content on what we have.

The line B. B. is intended as an approximate for untreated hemlock and C. C. that for mountain untreated pine ties, presuming that much the same law will govern as with the treated ties.

Granting that the diagram is anything near right, it speaks "graphically" for itself.

ON THE ECONOMIES OF TIMBER PRESERVATION.

(Copy)

ON LINE, Sept. 14, 1902.

MR. H. U. MUDGE,
General manager, A. T. & S. F. Ry.,
Topeka, Kan.

Dear Sir:—I beg to acknowledge receipt of your favor of September 8, which was forwarded to me while on the line west, giving figures showing the average life of treated ties taken out of track during the year 1901. It would seem from the statement that the best results you receive from your Rio Grande division, next coming the New Mexico division. From the divisions east of the Western division, it would seem there was not much economy in the use of the treated tie, the average life being

practically eight years. Of course, this is considerably over the life of the tie untreated, still at the same time the additional cost of the treated over the ordinary pine without treatment would, in my mind, make up the difference. I should be very glad indeed to hear from you on this subject, and whether you consider the tie economical to use east of our Western division. Yours truly,

(Signed) RUSSELL HARDING,
3d Vice-Pres. and Gen'l. Mgr. Mo. Pac. Ry.

(Copy)

TOPEKA, KAN., Sept. 26, 1902.

Tie Treating Report.

MR. RUSSELL HARDING,
3d Vice-Pres. and Gen'l. Mgr. Mo. Pac. Ry.,
St. Louis, Mo.

Dear Sir.—I am in receipt of yours of the 14th inst., hereon, and note contents. It would probably have been better when these reports were sent out if special attention had been called to the fact that the figures represented only the average life of treated ties taken out on account of rot during 1901, and not the average life of all the ties treated during each year.

We commenced wood preservation in 1885 at our Las Vegas plant, treating only mountain pine and laying the ties west of Dodge City, Kansas, but principally in New Mexico. Unfortunately, it was not until 1897 that we realized the necessity of keeping record of the service obtained through this work, so that from 1885 to 1896 inclusive, while we put in 2,528,748 treated ties, we have no record of how many were taken out each year or the reason, consequently cannot give any present average life of service, for those still in, and must, until our present records are old enough, be content with knowing the average life of those taken out.

In 1898 we commenced getting treated Southern pine ties from the Texas plant at Somerville, but these have not yet been in long enough to give us re-

liable data from which to determine the percentage of saving, although the Southern Pacific, who have been treating loblolly sap wood since 1886, using the same system of treating that we have, that we now use, claim that it about doubles the life of the tie at less than one-third its cost. This is practically our own experience, even judging by the ties which have come out of the Western end where we have had long enough time to base an opinion upon. You will see by the record sent that in 1901 we took out 4,472 mountain pine ties which have been in the track since 1885—sixteen years' service, when at the most without treating we could not have expected more than six years, and I am satisfied there are quite a few thousand ties of 1885 yet in the track and good for two or three years more service.

Answering your remarks as to the economy of treated ties east of our Western division, in considering this it would not be fair to include the number taken out from "other causes," which cover those broken in accidents or removed for reasons entirely outside of the question of treatment; but when the number removed on account of rot is considered alongside of the total number put in, it will be seen that it bears a very small proportion to the number inserted in track, as you will see by figures given:

In connection with these figures, and with our averages as a whole, it must not be overlooked that it is the "weak sisters" which come out first; the strong, sound ones remaining in a much longer time under the principle of the survival of the fittest.

I certainly consider that our experience and economy also warrants us in the use of treated ties on the whole of our road, and believe good results will be apparent in course of time from those put in on the Eastern end, as well as on the Western. This year we had to put in a good many ties not treated, but it is because we are unable to get all of the other kind that we called for.

STATEMENT.

TREATED PINE TIES.

Eastern end, east of Western and Colorado Divisions.

Taken out between March 1, 1897 and December 31, 1901.

Entered against year in which they were treated.

Year in which treated and put in track.	Ties in Track Jan. 1, 1902.	Rotten.	Other Causes.	Total
1897.....	27,881	27,818	11*	13
1898.....	314,126	314,066	37†	60
1899.....	658,776	658,664	.....	111
1900.....	787,377	786,789	5	588
1901.....	658,694	658,676	.....	18
Total.....	2,446,903	2,446,013	53	790

Western end.

1897.....	242,750	242,309	305*	136	441
1898.....	334,058	333,727	101†	230	331
1899.....	351,570	351,359	21	190	211
1900.....	375,182	375,121	.....	11	11
1901.....	402,540	402,483	2	55	57
Total.....	1,706,050	1,704,999	429	623	1,051

Total on A. T. and S. F. proper.

1897.....	270,581	270,127	316*	138	454
1898.....	648,184	647,798	188†	253	391
1899.....	1,010,345	1,010,028	21	301	322
1900.....	1,162,509	1,161,910	5	594	599
1901.....	1,061,284	1,061,159	2	78	75
Total.....	4,152,868	4,151,017	488	1,359	1,841

*Mean for 4 years rotten .00094
 †Mean for 3 years rotten .00021 } - - - - ROWE.

We expect to have more and special attention given to this wood preservation matter in the future, and through our own experiments in a small plant put up here for that purpose, and are in hopes of so improving our treatment as to get even better results than in the past. (Sig.) H. U. MUDGE,
 General Manager,
 A. T. & S. F. Ry.

COST OF TREATING TIES.

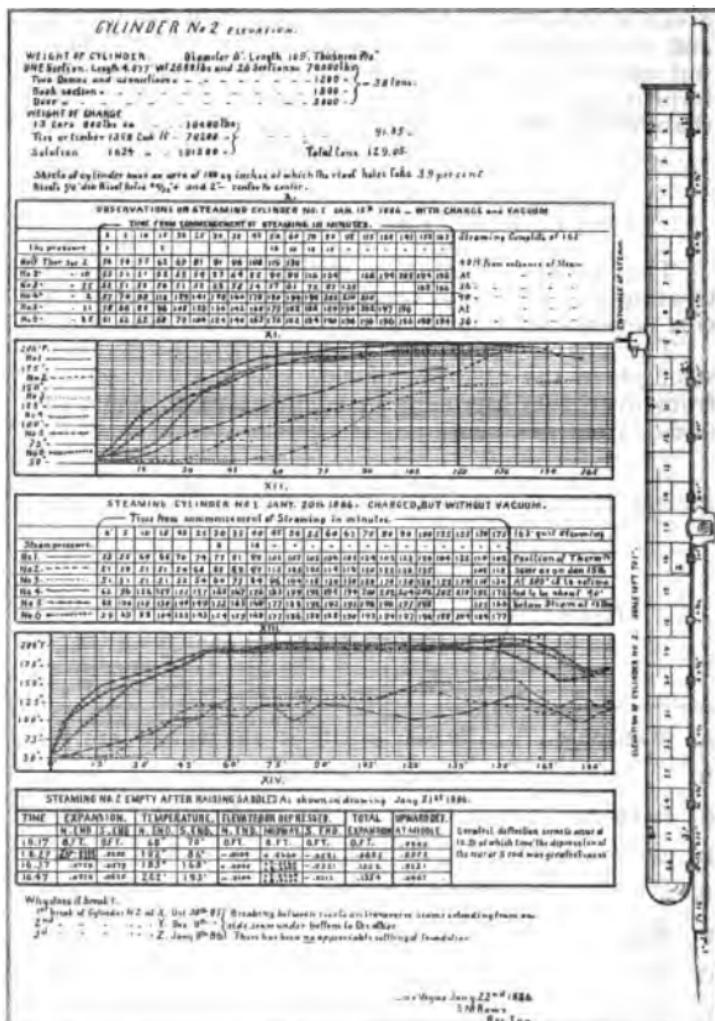
The appended table gives the average cost of treating ties at the several plants. This is the net cost covering chemicals, labor, fuel and supplies only.

The character of the timber varies so that the strength of the chloride of zinc solution also varies from over four per cent in some cases to one and one-quarter per cent.

TABLE.

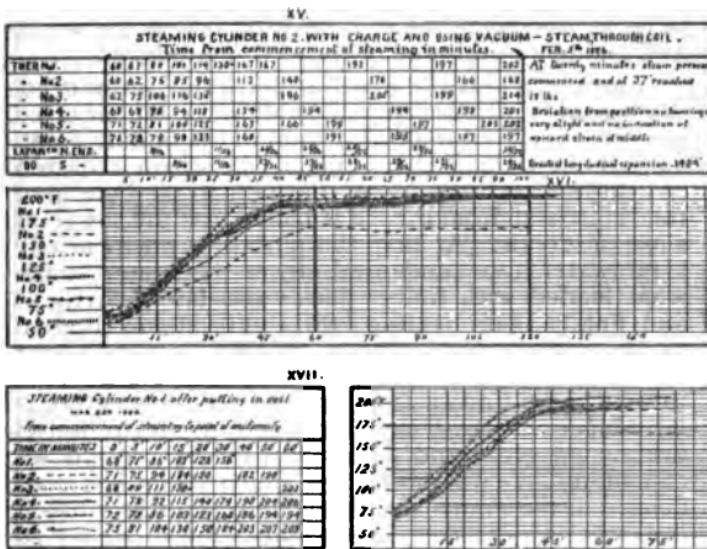
Process.	Cost of				
	Chemicals.	Labor.	Fuel.	Supplies.	Total.
A. Wellhouse.....	.00680	.0343	.00058	.0026	.01107
B. " .....	.0842	.0469	.0043*	.....	.1354
C. Burnett.....	.0616	.0709	.0037*	.....	.1962
D. Wellhouse.....	.0885	.0908	.0038	.0032	.1258
E. " .....	.0716	.0345	.0084	.0021	.1168
F. Burnett.....	.0554	.0829	.0086	.0015	.0984
G. Wellhouse.....	.0323	.0336	.0143	.0026	.0828
H. Burnett.....	.0622	.0268	.0025*	.....	.0915
I. " .....	.0869	.0279	.0088	.0033	.0764

*Supplies included.



INTRODUCTION OF STEAM TO THE RETORT.

In 1885, when the Las Vegas plant was first installed, the steam was introduced through the upper dome near the middle of the retort. Great distortion of the shell of the retort was at once apparent and several breaks by tearing the steel sheets succeeded each other at short intervals. These failures were at the bottom of the retort near the middle and were quite expensive to repair, requiring large patches.



It was evidently due to the sudden heating of the top of the retort before the steam reached the bottom, the top sheets being expanded so as to throw it into an arch, causing tension on the bottom sheets beyond what they would stand.

The whole difficulty was remedied by introducing the steam at the lower dome and carrying it to each end and there discharging it, thus filling the whole area of the retort with steam, the air being allowed to escape through the top dome as fast as the steam from each end displaced it.

The diagrams here given, with one given on page 57 of the hand-book, will sufficiently illustrate the causes of breakage as well as suggestive of the remedy to be applied.

MEASURING THE SAPS EXTRACTED DURING THE PROCESS OF STEAMING.

In seeking a method of determining the amount of saps or soluble matter extracted during the process of steaming, the only practical method would seem to be by observing the changes in weight of the wood, and taking careful note of the effects produced.

Assuming that the wood is dry when introduced, the steam is introduced and held under the required pressure until the wood is heated to the boiling point. In practice we find that much of the steam required to heat the wood condenses and falls to the bottom of the retort and from thence is blown into the sewer at short intervals. At first this outfall is pretty nearly clear water from condensed steam, then later somewhat loaded with timber juices and later heavily so and finally again bearing nearly pure steam condensation. Then the vacuum follows, drawing the vapors from the timber and from the retort. If at this stage the timber is withdrawn from the retort, if introduced dry, will have increased in weight, but if introduced green and sappy, will be lighter, but we cannot tell in either case how much steam has condensed in the timber during steaming and how much is drawn away during the vacuum. But if we weigh the timber before treated and then again after, we have the increased weight, and by the tub gauge we have the amount actually absorbed.

Invariably this latter quantity is much greater than the increase in the weight of the timber by treatment. Then the difference is evidently the amount of sap or soluble matter drawn from the timber. In no other way can this be determined during the ordinary process of treating timber.

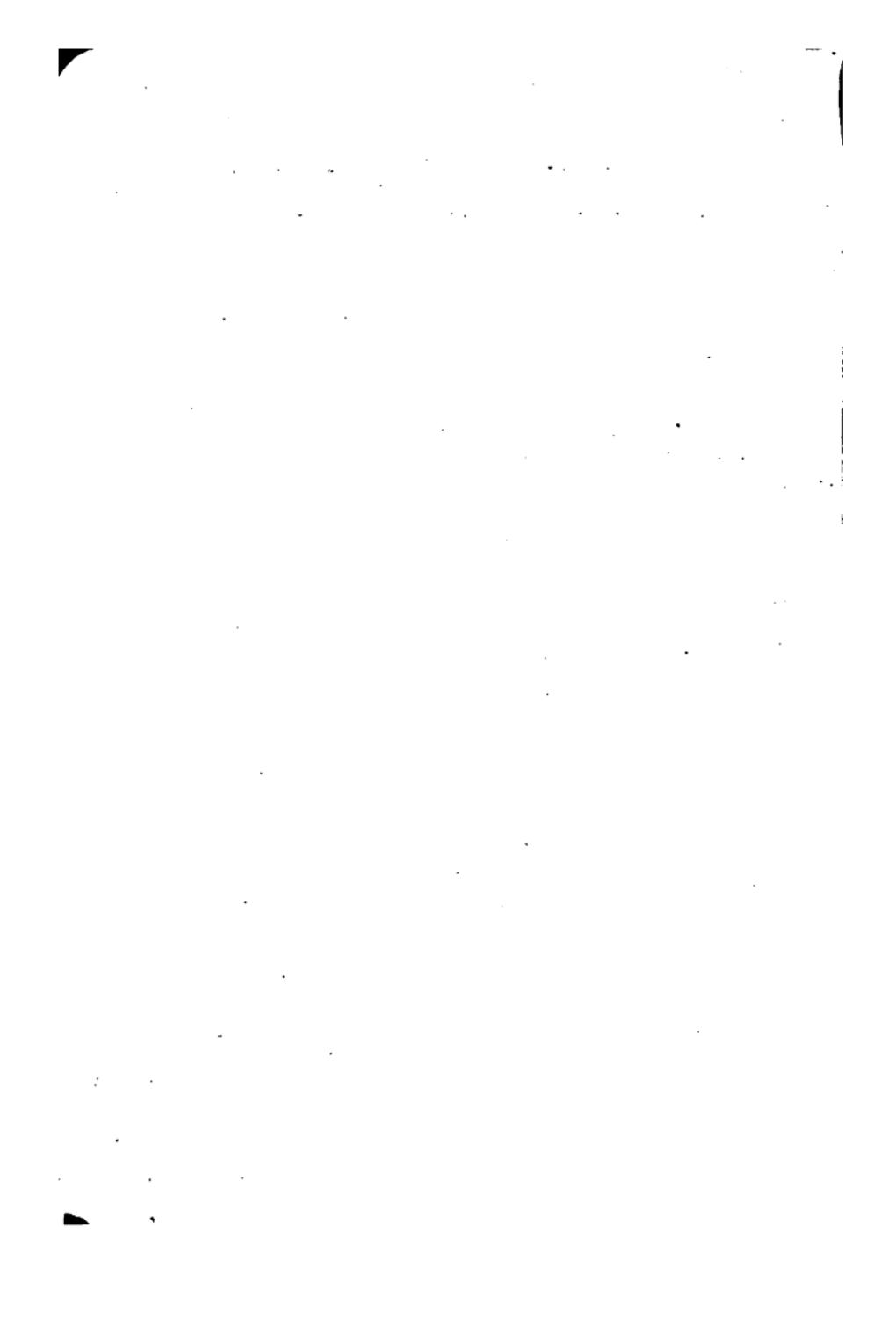
RULE.—Subtract increase of weight of timber from weight of solution absorbed. This difference is the weight of soluble matter drawn out.

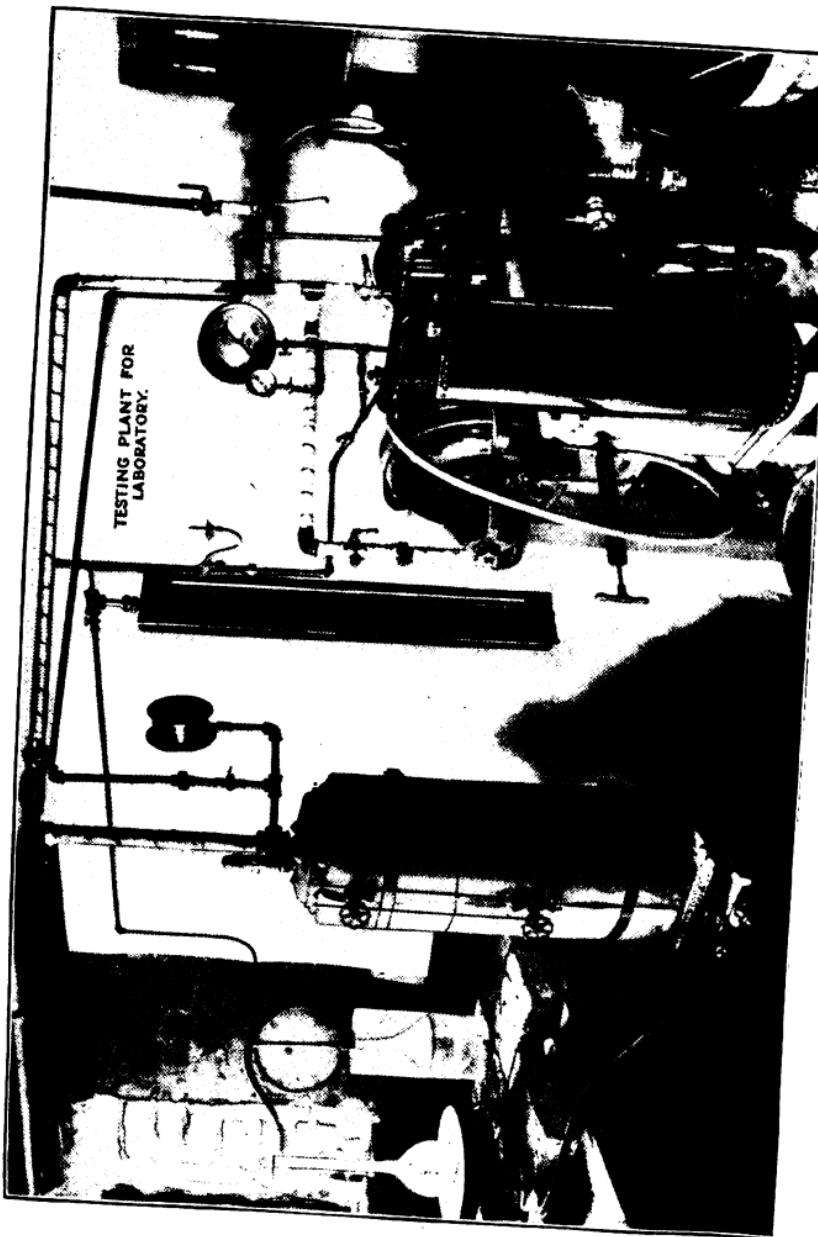
(E)

ABSORBENT PROPERTIES OF TIMBERS, WEIGHT &c.

No.	Kind of timber	Where found	WEIGHT ON SAF.	WEIGHT OR SAF.	SPEC. WEIGHT PER CUB. IN. 0.934. 128	ABSORPTION IN VOL.									
						3 Yrs.	6 Yrs.	9 Yrs.	12 Yrs.	15 Yrs.	18 Yrs.	21 Yrs.	24 Yrs.	27 Yrs.	30 Yrs.
77	Sugar Tree.	Fox River By H.D.	114	14.7	7/17	—	—	—	—	—	—	—	—	—	—
78	Huckleberry	Barren Eng.	370	40.8	6.54	"	"	"	"	"	"	"	"	"	"
79	White Ash.	H.T.	350	37.0	6.06	"	"	"	"	"	"	"	"	"	"
80	Hickory S.B.	"	447	48.2	7.74	"	"	"	"	"	"	"	"	"	"
81	Sycamore.	"	379	41.0	6.57	"	"	"	"	"	"	"	"	"	"
82	Linden.	"	253	27.3	4.38	"	"	"	"	"	"	"	"	"	"
83	Wild Cherry.	"	420	45.4	7.28	"	"	"	"	"	"	"	"	"	"
84	Red Elm.	S.M.R.(C.)	367	38.1	5.32	"	"	"	"	"	"	"	"	"	"
85	Mich. Pine.	"(d)"	261	28.2	4.72	"	"	"	"	"	"	"	"	"	"
86	"	"	261	28.2	4.62	"	"	"	"	"	"	"	"	"	"
94	Cypress (S.)	Whitmore	331	35.7	5.72	"	"	"	"	"	"	"	"	"	"
95	" (L.)	Greenville Trans. Mar. 9	359	38.7	6.21	"	"	"	"	"	"	"	"	"	"
100	Rock Elm.	C.N.W.Ry. 11/9	440	46.9	7.95	"	"	"	"	"	"	"	"	"	"
101	Mexican P.	Trans. Mar. 9	350	48.7	6.21	"	"	"	"	"	"	"	"	"	"
102	"	"	254	27.5	4.40	"	"	"	"	"	"	"	"	"	"
103	"	"	249	27.0	4.33	"	"	"	"	"	"	"	"	"	"
104	"	Celaya	265	28.6	4.59	"	"	"	"	"	"	"	"	"	"
105	Timetindin	Yucatan	270	29.1	4.67	"	"	"	"	"	"	"	"	"	"
106	"	"	360	38.9	6.24	"	"	"	"	"	"	"	"	"	"
107	Oyamel P.	Celaya	278	30.0	4.81	"	"	"	"	"	"	"	"	"	"
108	"	"	251	27.1	4.34	"	"	"	"	"	"	"	"	"	"

*Official Report
January 20th 1904.*



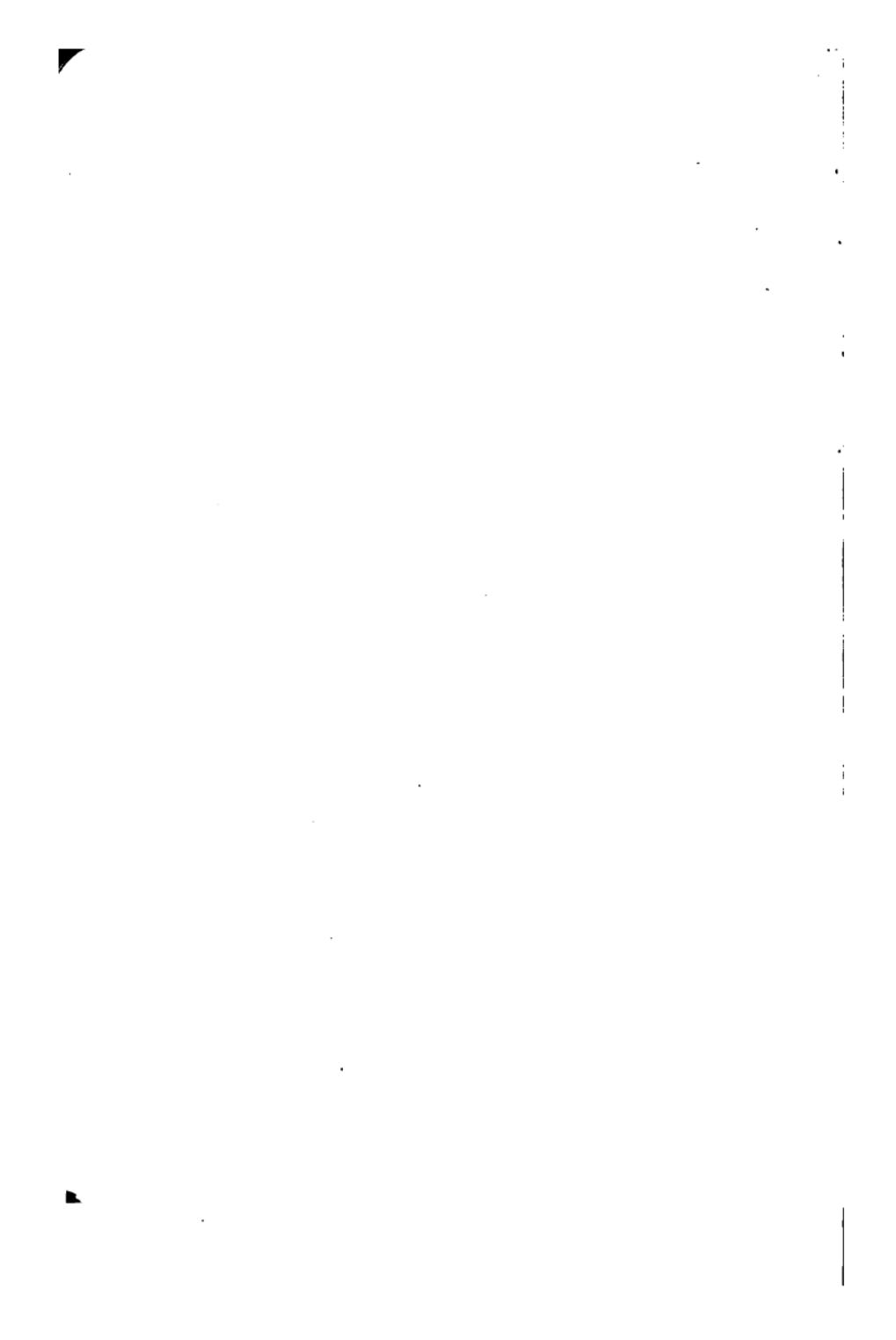


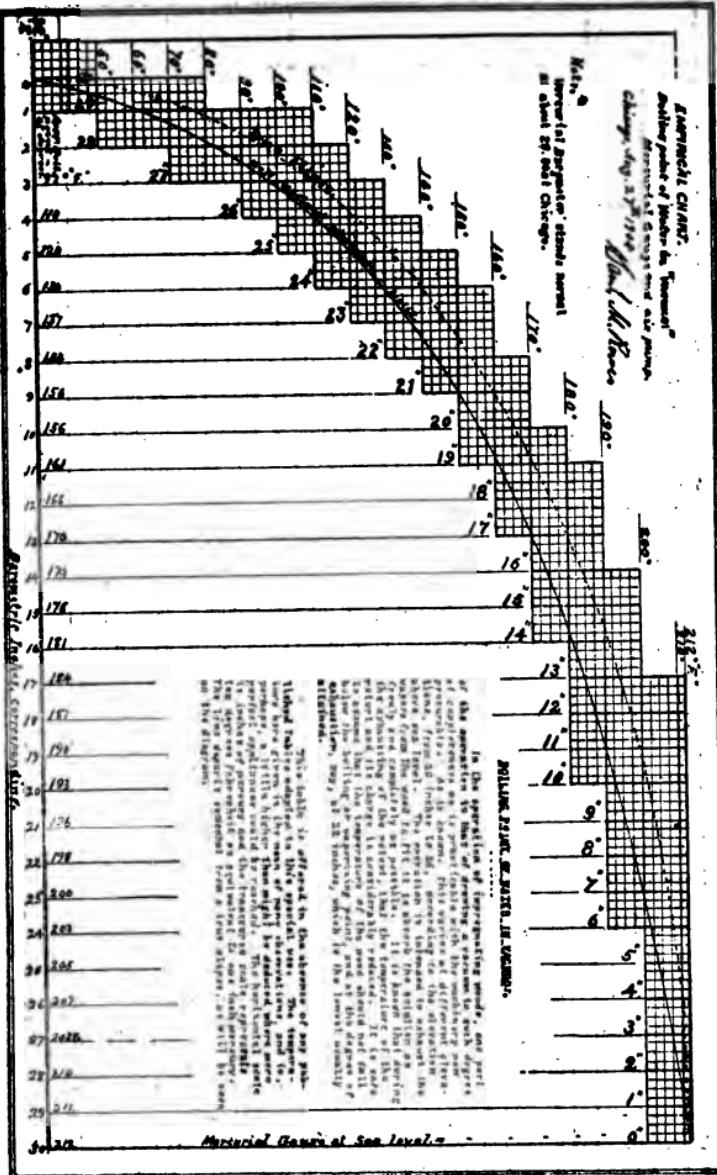
TIMBER IMPREGNATING

**HAROLD C. HOLLOWAY,
CONSULTING ENGINEERS,**
P.O. BOX 864 Waukegan,
CHICAGO, ILL.

1

2





NOTE.—With more perfect instruments the boiling point is between the line given and the ellipse, perhaps very near the latter.

Champagne 11th of October, M. Brown.

The table here given is results of investigation made by the aid and co-operations of three operators of Timber Preserving Plants, F. J. Angier of Sheridan, Wyoming, H. J. Whitmore of Grahville, Texas, and F. H. Stewart of Alamogordo, New Mexico, at request of the author. The primary purpose was to determine as near as possible just what takes place as regards physical conditions during the operation. Each one, aside from the program furnished, carried through the operation entirely independent of each other and the uniformity of mean results, fully attest the care and ability with which each conducted the experiment.

One question recently brought to the front by the theorist, has been the amount of heat attained by the timber during steaming and vacuum, it being urged that during the producing the vacuum, the temperature of the steamed timber became reduced, so that a portion of the vapors in the timber would again condense and thus fail to be drawn out. It is, therefore, urged that a coil of superheated steam should be used to keep the temperature above the vaporizing point until the vacuum was fully drawn.

Now let us see: In any case the vacuum drawn is never less than 22 inches and at this point water boils at 140° Fahr. against 212° at atmospheric pressure. Referring to the table, we find that the mean temperature at completion of the vacuum is 158° F., and the minimum 135°, nowhere as low as the boiling point in 22 inches vacuum, except in one run. It would seem, therefore, that a superheater coil is not needed.

Another point brought out is, that during the steaming the boiling point is reached in a majority of cases, allowing for the elevation above the sea and the imperfect method resorted to, that of withdrawing the car and pushing the thermometer into a hole previously prepared.

Then again, it will be noted that dry ties age almost invariably heavier after the vacuum is drawn by about 4 per cent, and green ties are lighter by about 2 per cent, than when introduced and that some very green are slightly lighter after steaming and before the vacuum is drawn. This is due to the large amount of water boiled out during the steaming, overbalancing the steam absorbed.

There are other significant matters brought out that will interest the experienced operator, and will, it is hoped, encourage further investigation in this direction.

Referring to matter of saps drawn from the wood as per page 180 (Hand Book, the column R.-J), is significant where none is shown in very dry ties, whereas very green ties give off over 20 lbs. per tie.

TREATED TIES.

C. M. & P. RR.

Year.	A	B	C	Year	C, remaining	Accumulated	C, 2 /S
1 1886	101,164	101,164	2,135	67W	2,133	.2,133 [#]	.0410 -
2 1887	2,62,317	363,4481	12,736	77W	12,735	14,869	.0403
3 1888	196,569	560,050	33,344	87W	33,344	48,213	.0822
4 1889	204,519	764,569	62,245	97W	52,245	100,453	.14445
5 1890	2,25,974	990,543	71,645	107W	81,645	182,150	.1533
6 1891	315,142	1,505,635	137,708	117W	105	299,864	.2,296
7 1892	310,645	1,610,238	160,854	127W	140,854	440,215	.2724
8 1893	365,287	1,921,565	185,865	137W	135,865	626,021	.3247
9 1894	320,344	2,241,879	22,369	147W	281,369	957,385	.3324
10 1895	142,961	2,354,740	249,863	157W	249,863	1,107,188	.46643
11 1896	82,639	2,4468,479	1,107,960				
12 1897	100,575	2,5769,062					
13 1898	55,164	2,622,226					
14 1899	162,471	3,790,700					
15 1900	163,172	2,953,872					
16 1901	215,919	3,169,361					
	TOTAL	3,169,861					

"AS NO TIRES COME OUT
UNTIL THE SIXTH YEAR

IT SEEMS EVIDENT THAT
THE 2/3'S WERE FROM THOSE

LAID IN 1886 AND SO ON
TO THE YEAR 1895. THE TIRES
WERE REMOVED. ALL THEREFORE

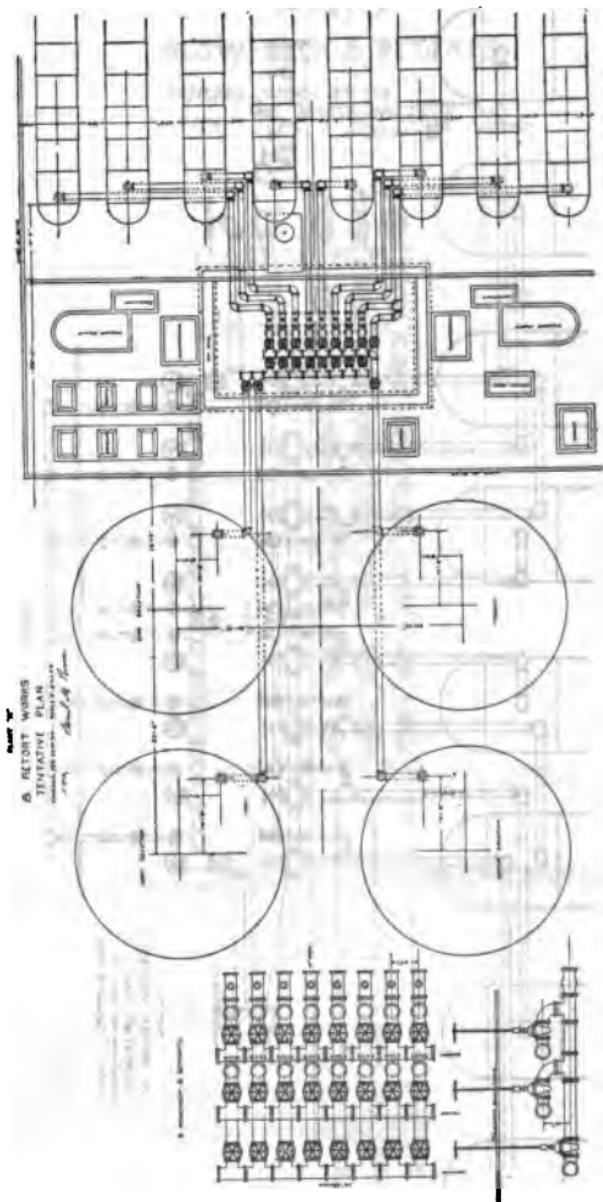
COMING FROM THE FIRST TEN
YEARS, AMOUNTING TO 46 $\frac{32}{32}$
% LEAVING 53 $\frac{67}{100}$ % STILLS.

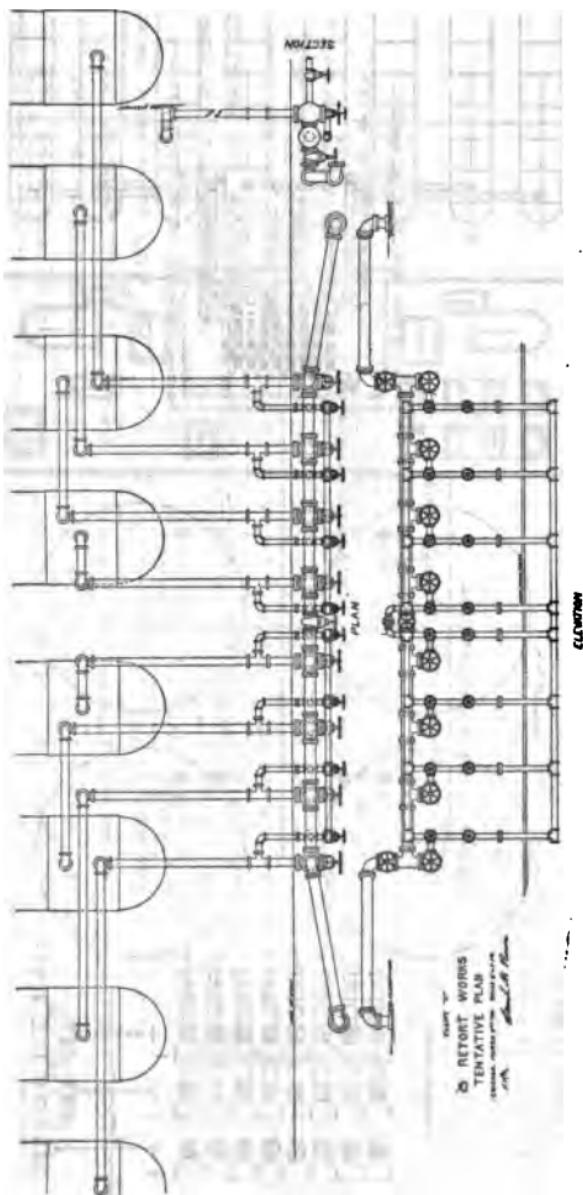
IN. MEANING A MEAN
LIFE OF 11.5 YEARS.

*Note:- A, NUMBER OF TIRES LAID
IN EACH YEAR AND C, THE
NUMBER REMOVED*

CHICAGO, MAY 18TH 1904.

Frank H. Horne?



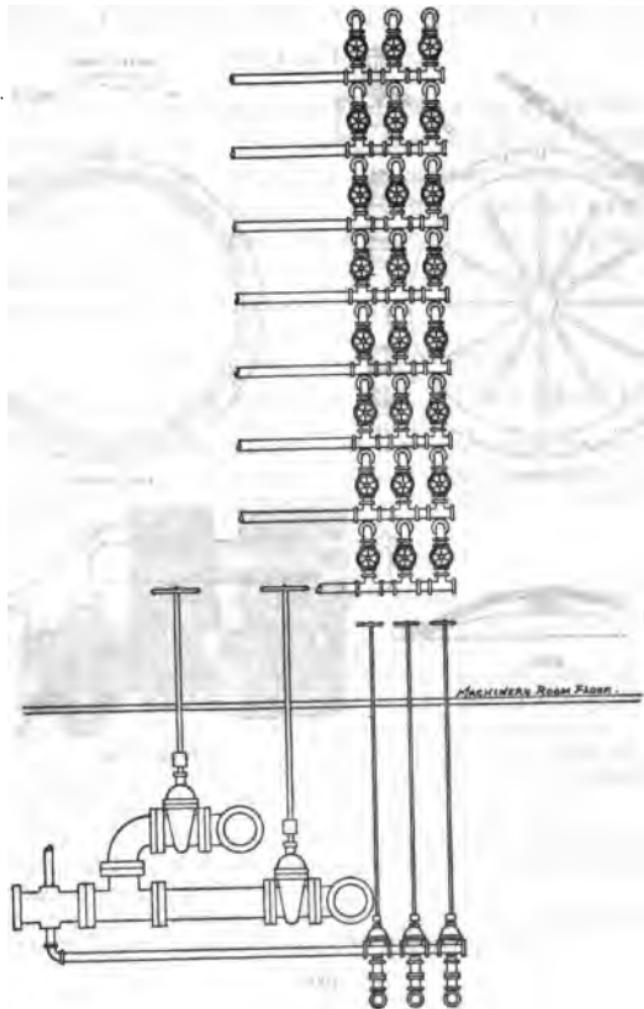


PLANT 'P'
BLOW-BACK 8 RETORTS

CHICAGO, MARCH 3rd '04.

F.M.

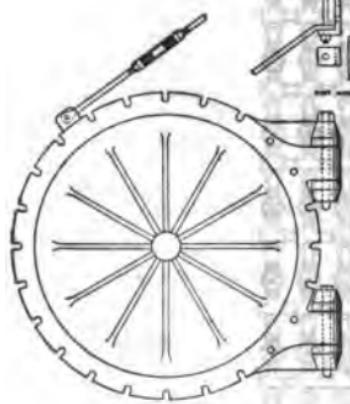
Frank M. Rose.



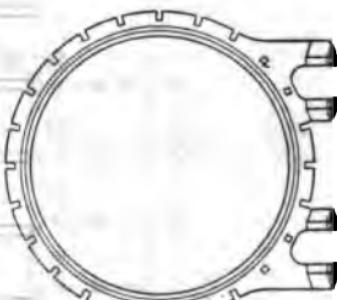
BOLTED DOOR

CAST STEEL

John A. Lewis



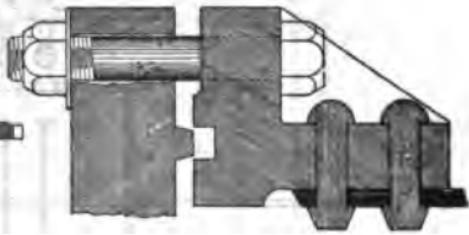
FRONT ELEVATION



FLANGE ELEVATION



SECTION



SECTION FULL SIZE

APPENDIX.

THE CREOSOTE AND ZINC-TANNIN PROCESSES.

It is deemed desirable that place be given to the following matter from one of the best, if not the best, posted men in regard to the matter here treated. OCTAVE CHANUTE, C. E., has that extended experience that must give his statements such degree of authority as to remain undisturbed except by the very best substantiated proofs.

WORKING INSTRUCTIONS.

MATERIALS NEEDED FOR IMPREGNATION.

Before the works are put into operation the necessary materials for injection have to be ordered and placed in their appropriate receptacles. Order as follows:

CREOSOTE.

Order in the ratio of $1\frac{1}{2}$ gallons per cubic foot of the quantity of timber which it is intended to creosote and to the following specifications:

"The creosote to be a pure coal tar distillate of the very best quality, free from water and all impurities, and on analysis to give the following results:

"1. To be entirely liquid at a temperature of 120 degrees Fahrenheit, and to remain so on cooling to 95 degrees.

"2. To contain not less than 25 per cent. of constituents that do not distill over at a temperature of 600 degrees Fahrenheit.

"3. To yield to a solution of caustic soda not less than 6 per cent. by volume of tar-acids.

"4. The specific gravity at 90 degrees Fahrenheit to range between 1.040 and 1.065, water being taken as 1.000 at the same temperature."

This is the English specification, and London governs the price for creosote all over the world. The firm of Burt, Boulton & Maywood are large dealers in England, and the Barrett Manufacturing Co. lead in the United States. The price fluctuates greatly.

The creosote will probably be received in barrels; these should be rolled over a gangway to the creosote storage tank and dumped therein. The oil will probably be fluid, but if it does not flow easily, a closed steam lance with flexible steam connection inserted into the barrel will cause its rapid emptying. From the storage tank the oil will be transferred by gravity or pumping in needed quantities to the creosote reservoir, under the retort.

Steam coils are placed in the creosote storage tank, in the creosote reservoir in the retort, and in the measuring tank if one is used. In addition to this, the main pipes connecting these various receptacles have a small internal pipe through which steam or its condensations circulate in order to keep the creosote hot and prevent clogging.

The tests of the creosote received will have to be made from time to time by a chemist, and it is recommended that he shall procure a copy of the book by Lunge, "Coal-Tar and Ammonia."

CREOSOTING.

This process consists of three operations:

1. Steaming the timber.
2. Producing vacuum and admitting creosote.
3. Application of pressure pump.

I. STEAMING THE TIMBER.

The timber being in the hermetically closed retort is first subjected to the action of steam, unless the wood is so thoroughly seasoned as not to require this. The time necessary for steaming depends upon the season and the kind and condition of the wood.

The object of this steaming is to put the timber in a condition to absorb the greatest possible amount of the preserving fluid, by dissolving and removing as much of the sap as possible, as well as whatever dirt there may be on the faces of the wood.

The admission of steam to the retort is to be so regulated that the gauge attached thereto shall indicate a steam pressure of 20 pounds at the end of not less than 30 minutes after beginning the process. This steam pressure is then to be kept up, without increase, for a further period, varying from 30 minutes to three hours, in accordance with the condition and kind of the wood. The greener it is the longer must the steaming be continued to extract the sap. The denser the wood the more does it require long steaming in order that the sap in the heart of the timber shall reach the boiling point. Very dense woods, with small and infrequent sap cells, should not be treated at all, as this will be a waste of money. The fact may be determined by weighing thoroughly seasoned specimens and rejecting the woods which weigh 50 pounds or more to the cubic foot when in that dry condition, or over 55 pounds to the cubic foot when half seasoned. Experience will have to guide.

In order to expel the air from the retort at the beginning of the steaming, a valve attached to the lower part of the retort must be opened until steam begins to escape; this valve must also be opened from time to time, or left with a very minute opening during the process of steaming, in order to draw off the water of condensation.

After steaming the wood for a sufficient length of time, the steam is allowed to escape from the retort. The steam valve and all escape valves are then closed before proceeding to pump a partial vacuum.

2. PRODUCING VACUUM AND ADMITTING CREOSOTE.

After the steam is exhausted from the retort, a vacuum of 18 to 24 inches of mercury, as indicated on the vacuum gauge, is produced, and this amount

of rarefaction must be kept up from 10 minutes to one hour, as experience with the kinds of wood operated upon shall indicate. Then, without decreasing the vacuum, i. e., without stopping the air pump, the creosote, previously heated to 120 degrees F., is admitted. This is done by opening the valve leading to the creosote reservoir under the retort, when the fluid rises through the action of atmospheric pressure, so as to fill the retort partially, the remainder of the filling and the application of pressure are effected by means of the pressure pump.

3. APPLICATION OF PRESSURE PUMP.

The pump is to be put into and continued in action until the pressure is raised to 100 pounds to the square inch, and this must be maintained, until the requisite amount of creosote has been forced into the timber, the air pump being shut off as soon as it is ascertained that the retort is full of creosote. The time requisite to produce absorption by the wood will vary from 30 minutes to three hours, and the amount to be injected will vary from ten pounds to the cubic foot for timber to be exposed only to the weather, to sixteen to twenty pounds per cubic foot for timber to be exposed in the sea to the action of marine worms; i. e., the *Teredo Navalis* or the *Limnoria Terebrans*. If necessary the time of pumping must be prolonged until the required amount of creosote has been absorbed.

In order to determine the amount of oil absorbed by each charge, two methods are employed. The first is to read accurately the gauges or indicator boards attached to the creosote tank and the creosote reservoir before and after the injection of the timber. From these readings the amount of oil absorbed by the charge is computed, and knowing the number of cubic feet in the charge the quantity per cubic foot is easily ascertained. If through any cause it is impracticable to measure beforehand the volume of charge, the amount of cubic feet which it contains may be ascertained approximately by

first gauging the cubic contents of the retort with only the empty buggies and the wire rope therein; then by reading the gauges, first, before admitting the creosote; second, when the retort is just full, and, third, after the creosote has been forced back; the displacement of the charge in cubic feet may then be computed, as more fully explained hereinafter.

The second method of determining the amount of oil absorbed by each charge is to weigh each buggy load just before and just after creosoting; the difference showing the weight absorbed, and this is presumably evenly distributed among the number of cubic feet in that buggy charge. This is probably the more accurate way, but it requires the introduction of a weighing scale in the track, or the handling and weighing of each piece of timber separately. In computing the result, the amount of sap previously extracted by the vacuum must be taken into account, and be added to the increased weight shown by weighing. This extracted sap can be measured through the hot well of the condenser, and its weight thus ascertained.

In case of any charge in which the timber fails to absorb the requisite quantity of creosote, the process may be repeated. The tar-oil, or creosote, is to be kept at a temperature of at least 120° F. during the whole operation of injection.

After the requisite quantity of oil has been absorbed by the timber, and this may be most accurately determined by adding a measuring tank to the works, the tar oil is then drawn off.

CREOSOTING.

The creosote or "dead oil" is to be stored in a metal tank (iron or steel), in which is placed a steam heating coil to bring and keep the oil at such temperature as shall be necessary to keep it entirely fluid or liquefied (say, 120 to 130 deg. F.).

The suction pipe of the pump by which the oil is to be handled enters the side of the store tank and has its inlet very near the bottom, by means

of which the oil is drawn to the pump and by it forced into the reservoir placed immediately under the retort or into the retort itself as during pressure on the charge.

The reservoir is also furnished with a heating coil by which the temperature of the oil is still further raised to such temperature as may be found desirable, not so high as to prevent or destroy the vacuum in the retort by which it must be caused to flow into the retort.

In case the vacuum should fail to fill the retort around its charge, then resort must be had to the force pump to fill the remaining by drawing preferably from the storage tank, although if the reservoir contents are not too hot, from it. This as well for creating proper pressure on the charge during its exposure to the oil.

INTRODUCING THE CREOSOTE TO THE RETORT.

The charge having been carried through the steaming process, the same as done in section I for the zinc-tannin process, and the vacuum drawn and held for the desired time to exhaust the freed saps from the timber, the creosote is allowed to flow up through the five-inch valve and connecting pipe joining the reservoir with the bottom of the retort by opening the valve "R," and at the same time opening an air pipe with which the reservoir is to be provided in order that atmospheric pressure shall act on the liquid in the reservoir, which should lift so much of it as will fill the retort, the full force being kept up by continuing the use of the vacuum pump.

When the retort is filled as nearly as practicable, then the valve "R" should be closed, the vacuum pump stopped and the pressure pump immediately started and the remaining space in the retort filled and pressure brought on the charge, preferably drawing from the storage tank, as this will tend

to keep up the supply and replace the amount absorbed by the timber.

DURING EXPOSURE OF CHARGE TO THE OIL.

When the charge is all in and the pressure pump in operation, steam is turned on the heating coil in the retort and the temperature of the oil is raised to that prescribed, say 170 to 190 deg. F., and so held until sufficient absorption is had, which being done, the residue of oil is allowed to flow back into its reservoir through the pipe and the valve "R" through which it entered. The charge of timber is allowed to drip until quite free from the clinging oil, the operation is complete and the charge is withdrawn.

OPERATION OF THE HEATING OIL.

The store tank, the reservoir and the retort have each its independent steam supply pipe from the main steam pipe in the machinery room, with a valve in each, convenient to the hand of the engineer by which each coil is operated as needed, and the outlet of condensations leading from each coil, enter one common steam trap, which in its turn has a discharge pipe leading to the hot water reservoir or the boiler feed tank, as may be desired. The operator should be guided by the necessities, being indicated by the thermometers placed upon the storage tank, the reservoir and the retort.

Read the gauges and the indicator boards at the proper times, and also the glass tube of the hot-well to the condenser, and fill out the blanks in the report of run.

Much of the knowledge necessary to be entirely successful must be derived from experience and a considerable exercise of judgment and careful observation. As regards the matter of temperature of oils or solutions, strength of solutions, time, steam or pressure shall be held and many other pertinent

matters; this depends so largely on the character of timber to be treated, to climatic conditions and to the specifications and methods to be used, that it would be impossible to explain this through the present means, and it can only be done by an experienced operator on the ground.

CHLORIDE OF ZINC.

The chloride vats are lead lined, so that the chloride can be made on the spot by pouring hydrochloric acid over metallic zinc (spelter) in case those materials can be procured, but it is assumed that it will be preferred to use the "fused chloride of zinc," which comes in iron drums. Order the latter in the ratio of one-half pound per cubic foot of the quantity of timber which it is intended to treat therewith. Fused chloride is made by a number of firms in Germany, which are well known to the chemical agencies, and by one or more firms in the United States.

A convenient way of handling the drums will be to roll them over the gangway above the chloride vats, there to chop off the sheet iron, which is quite thin, with an axe, and to chop the chloride into suitable pieces to throw into the vats, using each alternately. By adding about the same weight of pure water as there is of the chloride and letting it stand a day or two, this dissolves into a "stock solution," which should read about 50 degrees with the Beaumé hydrometer. From this "stock solution" appropriate quantities are to be thrown up by the steam jet into the chloride storage tank, to produce the strength of "working solution" desired, which will vary probably from 2° to 5° Beaumé, in accordance with the condition of the timber to be treated, as more fully stated hereafter. When the general conditions of the working have been arrived at, much labor of computation will be saved by preparing a table showing how many tenths of feet from the chloride vat, should be mixed per foot of water in

the storage tank in order to produce the strength of "working solution" required.

The testing of the chloride of zinc will have to be made from time to time by a chemist. It should be as free as possible from impurities, and especially from iron. The chemist will indicate what simple tests can be applied at the works to test for iron, free acid, sulphates or basic chloride when he is not present.

GELATINE.

Order dry glue in the ratio of 1-10 of a pound per cubic foot of the quantity of timber which it is intended to treat by the zinc-tannin process (somewhat less will be used). If moist glue is to be had, order twice the above quantity, as it contains about 50 per cent of water. It is not requisite that the glue shall be refined and the cheaper grades will answer very well, provided they are rich in gelatine. This is to be ascertained by testing a sample dissolved to a syrup between the fingers, and noting its degree of adhesiveness, and also by making a solution 2 per cent strong and mixing in a test tube with a solution of tannin of the same strength. The glue which will yield the largest volume of pellicles of insoluble artificial leather is the best to use.

The glue is to be dissolved in the appropriate cooking tub with hot water (best obtained by steaming) into a "stock solution" of convenient strength, whence it is to be thrown up by the steam jet into the gelatine storage tank so as to produce a "working solution" 1 per cent strong, in terms of dry glue. The exact strength is not essential, as the office performed by the gelatine and the tannin is to produce pellicles of an insoluble substance which obstructs the washing out of the chloride of zinc.

TANNIN.

Order liquid extract of tannin in the ratio of 1-10 of a pound per cubic foot of the quantity of timber which it is intended to treat by the zinc-tannin pro-

ess (somewhat less will be used). The most suitable is the extract of hemlock bark which is made in Pennsylvania and in Michigan, and which contains about 30 per cent of tannic acid (in terms of oxalic acid), and is sold by the pound. It is practicable, however, to use other varieties of tannin, such as extract of oak-bark; of willow bark, or of chestnut, catechu, sumach or gambier. If tannin containing barks are to be obtained locally it may be cheaper to make the extract on the spot, the essential point being that the "stock extract" shall contain about 30 per cent of tannic acid, in terms of oxalic acid. This "stock extract" is to be emptied into the appropriate cooking tub, steamed, and thrown up by the steam jet into the tannin storage tank in such quantities as to form therein a "working solution" containing 2 per cent of the tannin "stock extract." The exact proportion is not essential and a little practice will enable the operator of the works to get at the correct proportion of water to be added to obtain a "working solution."

CONDITION OF TIMBER.

The condition of the timber before treatment is the most important element of success. The wood should be seasoned, or at least half seasoned, and this can best be ascertained before beginning operations by measuring and weighing samples of wood, two or three cubic feet in contents, when fresh cut and when thoroughly seasoned, so as to ascertain their weight per cubic foot. The difference between the two weighings will indicate the amount of the watery portion of the sap which has evaporated, and of the amount of solution which can probably be injected; this serving as a guide in selecting those woods which should preferably be employed. After these datas have been obtained, experience will guide as to the length of time and the mode of seasoning which are requisite to obtain good results. In Europe wood is seldom treated before it has been seasoned from 6 to 12 months. In the United States

wood is generally treated some 4 to 6 months after it has been cut, but the results are inferior; save on the Pacific Coast, where it is said that Oregon fir seasoned in the air 2 years will take double the time for treatment which is required for one freshly cut. This probably results from the presence of resin in the wood, which gums upon seasoning.

PREPARATION FOR WORKING.

The first requisite is that the engineer who is to operate the works personally shall thoroughly know and understand all parts of the plant. The retort, the working tanks, and especially the piping and valves, so as to know what motions to make to produce certain results. After he has made adequate studies of these and the tanks have all been charged with the liquids of the requisite working strength, the operation consists essentially in the following actions:

1. Charging buggies, placing in retort, closing door.
2. Steaming not over 20 lbs. pressure.
3. Producing vacuum of 18 to 24 inches.
4. Introducing solutions and applying pressures.
5. Forcing surplus solutions back into tanks.
6. Opening door of retort and withdrawing charge.

The details for these actions are given under the appropriate headings in the instructions to the engineer, but general instructions for some of them are as follows:

I. CHARGING BUGGIES, ETC.

The loads on the buggies should fit the interior of the retort as completely as practicable. This is best attained with green operatives by using the index frame, with rotating arms, which will sweep the circle of permissible loading when placed on the track against the buggy. In a short time the men will learn to do without it. Care should be taken that the loads should present square faces front and rear

on the buggies, as they are to be switched about with the wire rope attached to the rear buggy, all the others being pushed by it. When hauling the load into the retort the "pulling in" rope attaches to the last buggy, passes into the retort, and through the hand hole and sheave to the winch, while the "pulling out" rope is attached to the then front buggy, is dragged in with the train, and remains in the retort during the treatment, ready to be fastened to after opening the door.

The door is closed by inserting and screwing up the hook bolts, going over them, round after round, to ensure even pressures. Before closing the door the packing in the groove is to be lightly gone over with moistened soapstone powder to prevent sticking. The door is opened by unscrewing the bolts. Some practice is required to avoid leakages, the insertion of the packing being an operation which must be carefully done.

2. STEAMING.

The pressure gage and the thermometer are to be carefully watched during the steaming, as the pressure may not be allowed to go over 20 pounds to the square inch, and the temperature over 240 degrees Fahrenheit, without danger of injuring the strength of the wood. The length of steaming will vary with the condition of the wood, and must be obtained by experience. In the case of thoroughly seasoned wood (an article which will seldom be treated) the steaming can be omitted altogether with profit.

3. PRODUCING VACUUM.

The air pump produces both pressure and vacuum. The latter is employed to exhaust the air and sap from the wood, and should range from 18 to 24 inches of mercury, in accordance with the condition of the wood, and the amount of solution it is desired to inject. The higher the vacuum the better the wood is prepared. The amount of vapor pumped

out of the retort and condensed in the condenser is measured in the hot well under the latter, and read off in the glass tube. If creosoting, the condensed vapor is saved, if working the zinc-tannin process it is run to waste.

THE ZINC-TANNIN PROCESS.

This process consists of five operations:

1. Steaming the timber.
2. Producing a vacuum.
3. Admitting chloride of zinc. Pressure.
4. Blow back, admitting gelatine. Pressure.
5. Blow back, admitting tannin. Pressure.

The steaming of the timber and the vacuum are to be carried out in exactly the same manner as for creosoting, and the remarks already made will apply.

The third operation consists in admitting the chloride of zinc solution, previously heated to 150° F., from the chloride storage tank, and in applying pressure with the zinc pump. The time during which this pressure is to continue will vary with the condition of the timber, but will generally be two or three hours, during which the pressure must be maintained at 100 pounds to the square inch, watching the gauge, and regulating the pump. When the wood has been fully injected the chloride solution is to be forced back with compressed air into its tank. The strength of the solution should generally be 3.5° Beaumé. If the timber is refractory this may be increased to 5° Beaumé.

4. BLOW BACK ADMITTING GELATINE PRESSURE.

The chloride of zinc solution having been forced back from the retort, the gelatine is next admitted, and upon this a pressure is applied of 100 pounds to the square inch for 30 to 60 minutes. The wood has already been filled with the chloride of zinc, but upon the removal of its pressure a certain portion has been driven out by the re-expanding of the air included in the sap cells, thus making some room

for the gelatine. This penetrates perhaps one inch, under the renewed pressure, but a portion of this is again driven out by re-expanding, thus making room for the fifth operation.

5. BLOW BACK, ADMITTING TANNIN. PRESSURE.

The gelatine having been forced back into its appropriate tank, the tannin is next admitted, and pressure is applied of 100 pounds to the square inch by the pump, for 30 to 60 minutes. This penetrates from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch, and on coming into contact with the gelatine forms an insoluble substance which obstructs the dragging out of the chloride of zinc during the alternate soaking and drying out of timber when exposed to the weather.

This last operation having been performed, the tannin is forced back into its tank and the treatment is completed.

The time occupied by these various operations as carried out at works in Chicago is as follows:

	Hours. Min.
Charging two retorts with ties (read tank gauges)	0 30
Producing steam pressure to 20 lbs. (read steam gauge)	0 30
Maintenance steam pressure (read thermometer)	3 —
Blowing off steam.....	0 15
Working vacuum pump to extract sap....	1 —
Admission chloride solution (read indicator)	0 30
Duration pressure on solution (read indicator)	3 —
Forcing back chloride solution (read indicator)	0 20
Admission gelatine solution (read indicator)	0 15
Duration pressure on gelatine.....	1 —
Forcing back gelatine solution (read indicator)	0 15

	Hours.	Min.
Admission tannin solution (read indicator)	0	15
Duration pressure on tannin.....	0	30
Forcing back tannin solution (read indicator)	0	20
Discharging the retorts.....	0	20
	<hr/>	<hr/>
	12	—

The time of these various operations may be somewhat varied, and can be shortened to 8 hours if the timber is well seasoned. In Europe, where the wood has been seasoned 6 to 12 months, the treatment with chloride of zinc (omitting gelatine and tannin) is done in about 5 hours. It is desirable to arrange the time occupied so that the discharging and recharging the retorts shall be done when the timber handlers are at hand to help. The works are generally run night and day.

CHECK OF WORK DONE.

The most accurate way of checking off the work done is to weigh each buggy load just before and just after treatment. The difference in weight shows the number of pounds of solution injected, and as the strength of the chloride of zinc solution is known before hand, the amount of dry chloride injected is computed by multiplying the weight by the percentage corresponding to the degrees Beaumé. The following table gives those percentages:

PERCENTAGES OF ZINC CHLORIDE.

Fractional degrees may be obtained by interpolation.

This method involves putting a track scale at some convenient point, and passing every buggy over it, stopping long enough to weigh it, and recording the results in a book. The buggies have also to be identified at each weighing, and tabular statements have to be made of the results. All

this takes time, and costs something for labor, so that it is somewhat cheaper to rely wholly upon the records of gauging kept by the engineers, which should be kept in any event, and which may serve as a further check upon the weighing, should the latter be done.

The operating engineer is to keep a record about as follows. It may be modified to suit circumstances:

RECORD OF OPERATIONS.*

From which record the results may afterwards be entered into a book under such headings as may be deemed most desirable.

The left-hand set of blanks gives a record of the time of each operation, and the right-hand set gives the data for calculating the results.

The computations are made in this way:

The retort has previously been gauged with the empty buggies and "pulling out" wire rope inside, and it is therefore known how many cubic feet it contains when in that condition. This will be about 1,210 cubic feet. The reading of the index or indicator on the zinc chloride tank has been taken at the beginning of the operation, thus showing how many vertical feet there are in the tank. The "return point" of this indicator has also been read after the chloride has all been forced back. Hence the difference between those two readings will show how many vertical feet from the tank have been absorbed by the wood, and this multiplied by the number of square feet per foot of tank, which will be 113.10, if it is just 12 feet inside diameter, will give the number of cubic feet of solution which has gone into the wood. From this the pounds of solution, or pounds of dry chloride, may be deduced by applying the appropriate factors.

To arrive at the cubic feet displaced by the charge, it is necessary to deduct the reading of "lowest point indicator" from the "return point indicator"; the difference, multiplied as before by the

*See page 78.—AUTHOR.

square feet of area, gives the number of cubic feet which the retort still contained after the wood had been injected, and by deducting from this the number of cubic feet which the retort holds when only empty ears are therein, we obtain the displacement of the load in cubic feet; from which the pounds of wood may be calculated by applying the proper factor. Both calculations will be greatly shortened by preparing tables corresponding to each vertical foot of tanks, after the latter and the retort have been accurately gauged.

The amount of gelatine and tannin solutions absorbed may be computed in the same way, but there is little interest in doing so, as the chloride of zinc is the real preservative.

The data for each run should subsequently be entered in a book, in such order as the nature of the work requires.

CREOSOTING TIMBER. DESCRIPTION OF OUR PROCESS.

"CREOSOTING."

"The timber is first loaded on cars and run into cylinders which are then hermetically sealed with immense iron heads. Steam is then admitted into the cylinder and surrounding the timber. Superheated steam is also introduced into the cylinders by means of large coils so that it does not come in contact with the timber, and the heat is maintained until the timber is heated all through at a low temperature so as not to injure the woody fibres. The cylinder is then freed of all vapors, and the vacuum pumps are put to work to exhaust all the sap and moisture, which is then in the shape of vapor, from the cylinder. Heat is maintained in the coils to prevent the vapor from condensing and thereby remaining in the timber. As the vacuum pumps are constantly removing the hot vapor from the timber it is absolutely necessary to keep the heat above the condensing point. To do this requires practical experience and means of knowing what such heat is, and as said before, those two parts of the process are the most important, and if properly done, the oil will be readily forced into the timber. After this has been done the oil is admitted into the cylinders while they are under vacuum, and when all air has been withdrawn they are subjected to pressure until the requisite amount (which is determined by correct gauges and thermometers) has been forced into the timber, which, if the timber has been properly prepared, is only a small part of the process, but if this has not been well done, the oil cannot be put into the timber. The cells of healthy timber are full of different substances, which, when subjected to heat, can be changed into vapor, and, unless the vapor has been completely removed, you

cannot force the oil into the timber, no matter how long the pressure has been applied. It is only by practical knowledge and delicate instruments that we determine when the heat has reached the center of the timber, and the vapor there formed has been removed.

"There will be no decay in any part of the timber that has been permeated with the oil, but to have all parts saturated is expensive and useless; for, after the timber has been thoroughly treated by the heat and vacuum process, it will last a long time without any oil, and if the crevices and pores are sealed up with the oil to a sufficient depth, the timber is as good as if the whole part has been thoroughly permeated with the oil. The quantity of the oil to be used should be determined by the use to which the timber is to be subjected.

"The Dead Oil of Coal Tar used by us in the treatment of timber contains carbolic and cressylic acids which were the only two substances out of the thirty-five examined by Dr. Calvert which perfectly prevented the growth of fungus life, while it is an established fact that timber impregnated with Dead Oil of Coal Tar offers perfect resistance to the ravages of the Toredo, the other insects, wet and dry rot.

"Dead Oil of Coal Tar is the only known material that effectually prevents the ravages of the marine worms and prevents decay."

EPPINGER & RUSSELL CO.,

First street and Newton Creek,
Long Island City, N. Y.

"THE GIUSSANI PROCESS."

The process consists of submitting the tie to a hot bath of anthracene and pitch, heated to about 140° C. (284° F.). This anthracene and pitch having a high boiling point, shows no signs of ebullition at this degree of heat. Immediately upon the introduction of the tie into this hot oil, ebullition takes place and steam and moisture passes off, showing conclusively that some of the constituents of the wood are passing away. After a period varying from 2 to 4 hours, this ebullition ceases, showing that the sap and moisture have completely passed off.

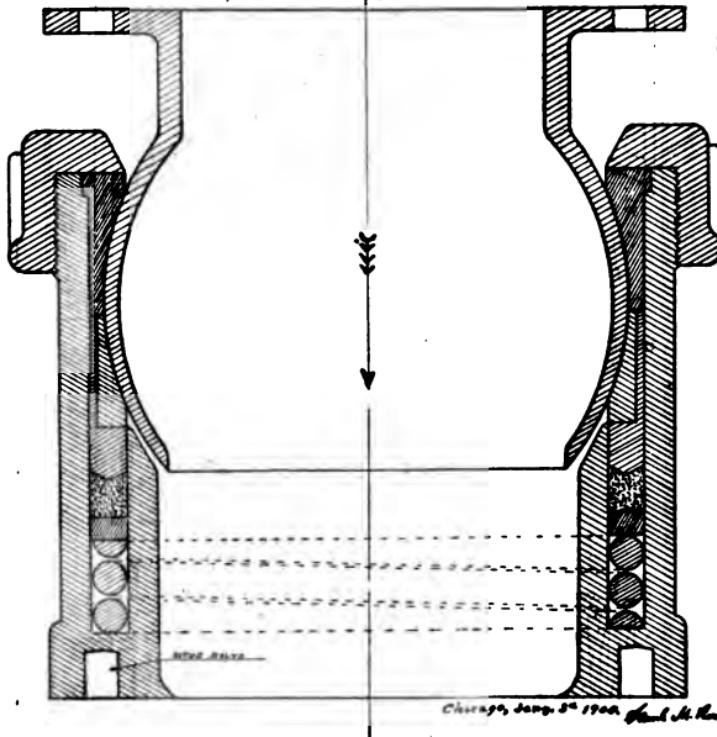
After the above heating process, the tie is transported mechanically into a cold bath of heavy oil of tar; remaining in this bath for a period of about 10 minutes, again, it is mechanically carried into a bath of cold chloride of zinc, and remaining there a variable time, according to the amount desired to inject into the tie.

If it is so desired, the tie can be treated with oil of tar alone. In fact, anything in a preservative line can be so injected into the ties.

A guarantee that Beech ties shall last as follows: About 75 p. c. must last 10 years, 25 p. c. 12 years, and 15 p. c. 15 years.

F. W. DRURY, Secy.

MARTIN OIL JOINT
THE HOLLAND COMPANY
CHICAGO.



The Martin Oil Joint is adopted in this case to give flexibility at three different points. First to allow the reach of the connection to be held by the tower in a nearly vertical position when not in use; to allow it to be lowered to connect with the pump on the vessel and to accommodate itself to the varying position of the vessel. The joint has a rotary motion on the perpendicular of its axis and also a limited movement from the axis. Three joints are here used.

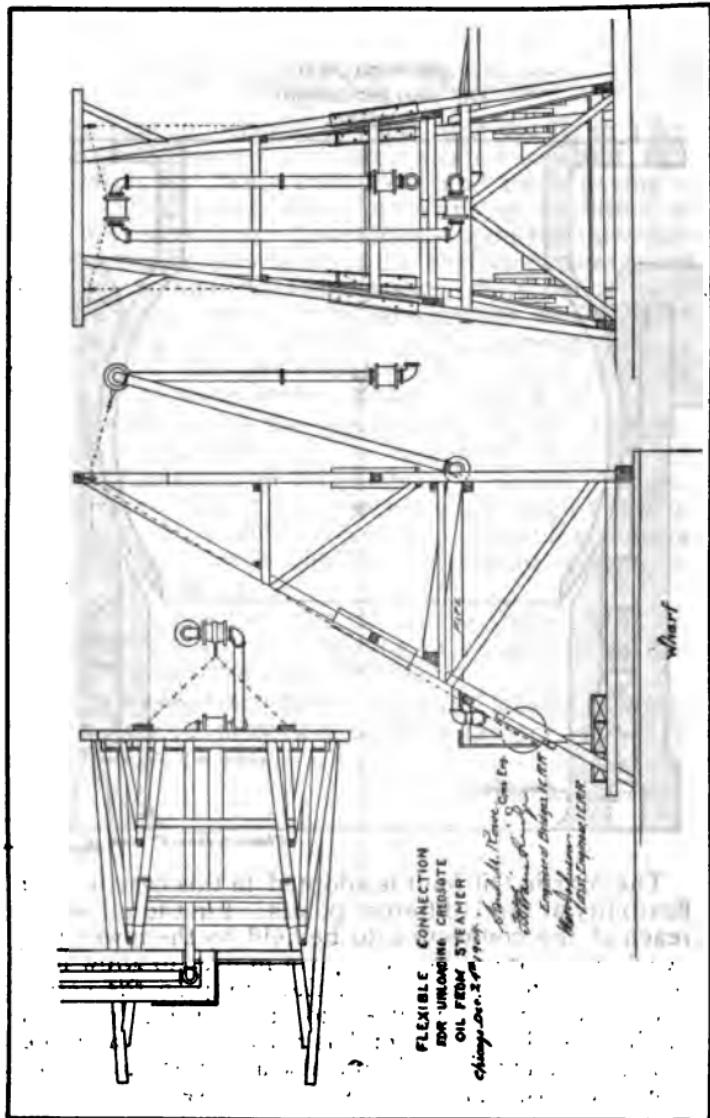


Table "B" in Its and Kilogrammes. (C 2.1046²)

	"S"	.50	.35	.40	.45	.50	.55	.60
C.	765.9 24.3	765.9 110.0	765.9 127.0	765.9 145.5	765.9 145.5	765.9 145.5	765.9 145.5	765.9 145.5
1/2 "	145.6	675.5	102.0	102.0	102.0	102.0	102.0	102.0
1/2 "	170.1	771.7	145.5	145.5	145.5	145.5	145.5	145.5
2 "	194.4	871.9	166.7	166.7	166.7	166.7	166.7	166.7
2 1/2 "	218.7	992.1	177.5	177.5	177.5	177.5	177.5	177.5
3 1/2 "	243.0	1125.1	225.3	225.3	225.3	225.3	225.3	225.3
2 1/2 "	267.3	1325.4	225.9	225.9	225.9	225.9	225.9	225.9
3 "	291.6	1325.9	255.0	1153.8	216.7	697.2	145.4	145.4
3 1/2 "	315.9	1425.7	270.8	1222.6	236.9	1024.7	215.6	935.4
3 1/2 "	340.6	1425.6	284.6	1222.6	246.3	1023.5	1023.0	1023.0
3 3/4 "	364.6	1625.5	312.5	1425.3	272.4	1244.5	240.4	240.4
4 "	388.9	1763.4	353.8	1511.6	291.6	1322.9	257.2	1175.6
4 1/2 "	413.2	1874.1	354.6	1665.2	308.9	1401.0	271.5	1244.6
4 3/4 "	437.5	1984.3	375.0	1760.4	322.6	1488.1	297.6	1322.7
4 3/4 "	461.8	2094.5	395.6	1873.8	347.6	1570.9	327.1	1425.7
5 "	486.1	2204.7	416.6	1977.5	366.6	1665.5	354.0	1523.5
5 "	74.4	63.1	87.2	87.2	91.7	96.3	101.3	107.3
All.	35.0	37.7	39.5	41.6	43.7	45.0	45.7	46.6

Chesapeake, Dec. 27 1904. *Frank W. Horne,*

TABLE B. Pounds "avoirdupois" with equivalent in kilograms.

RE-ATTACHMENT TO RENTAL AND SANTAFE "RAILWAY"—RECORD OF TREATED DISEASES LAID AND PREMUNED.

Posto: *Amorim & Sons*
Belo Horizonte, May 22, 1945 *G. B. Gomes*

Eleganza

Record of treated ties laid and removed A., T. & S. F. Ry., 1904.



LAS VEGAS PLANT A. T. & S. F. R.Y.



LAS VEGAS PLANT A. T. & S. P. R.Y.

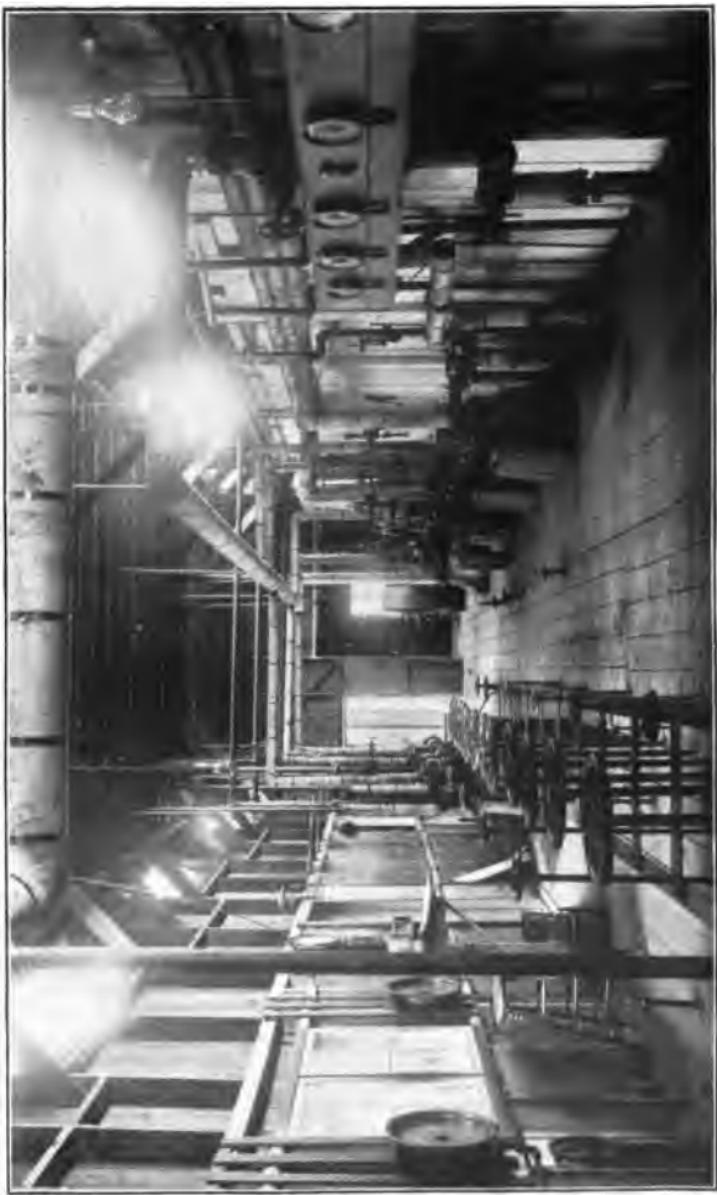


ORIGINAL TWO-CYLINDER ZINC-TANNIN PLANT AT LAS VEGAS, N. M.

SIX-CYLINDER ZINC-TANNIN AND CREOSOTE PLANT AT SOMERVILLE, TEXAS.



MACHINERY ROOM, SOMERVILLE, TEXAS.

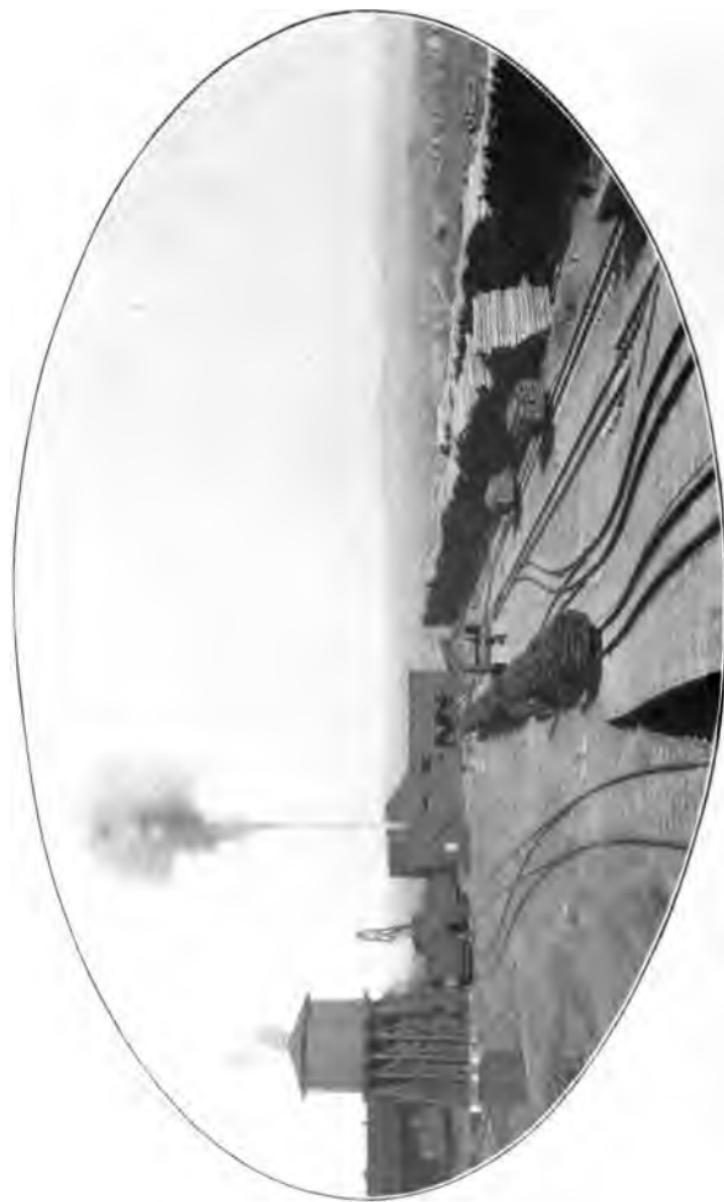


C., B & Q WORKS, SHERIDAN, WYOMING.



EDGEMONT BURNETTIZING PLANT DURING ERECTION.





BURNETTIZING PLANT OF THE C. B. & Q., AT EDGE MONT, S. D.

MACHINERY ROOM, BELLEMONT, ARIZ.





TWO RETORT WORKS. SANTA FE PACIFIC, BELLEMONT, ARIZ.

MACHINERY ROOM, SOMERVILLE, TEXAS.



REPORT. U. P. AND O. R. & N CO'S PORTABLE PLANTS. H. & R.

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MACHINERY ROOM. G N. R.Y.



SOLUTION PIPES FOR THREE MOVEMENT PROCESS. G. N. R.Y.

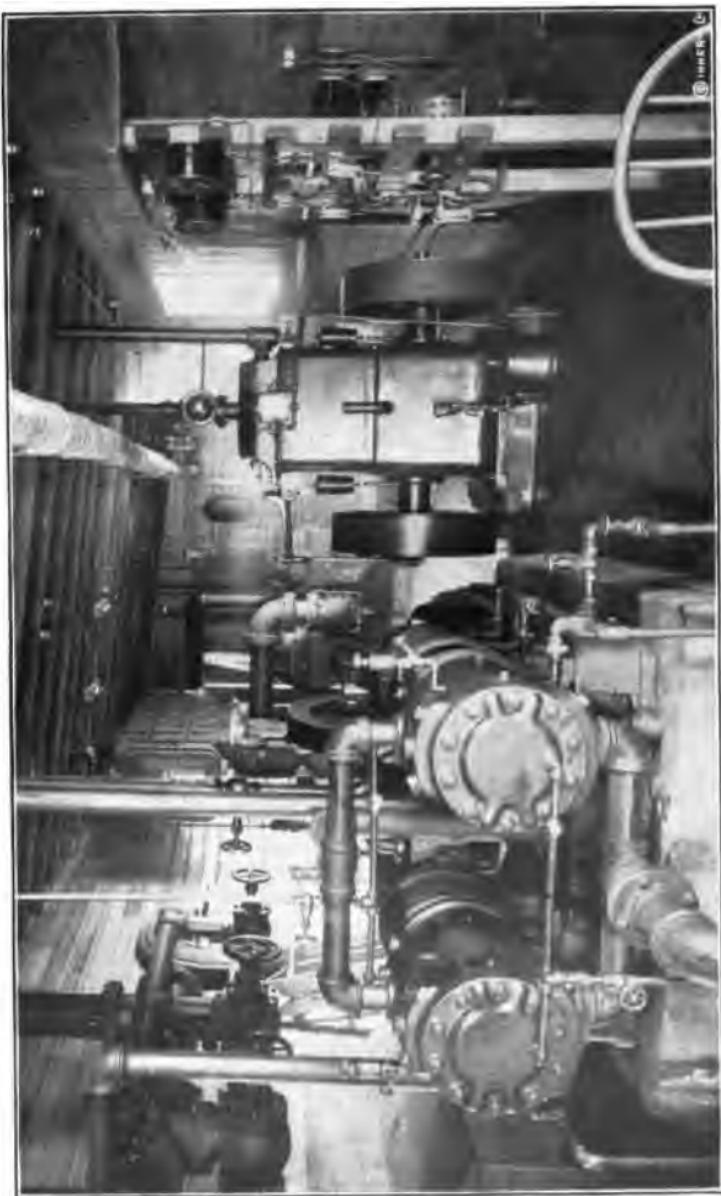




G. N. WORKS DURING CONSTRUCTION.



MACHINERY ROOM, SHERIDAN, WYOMING.



C. & N. W. RAILWAY WORKS, AT ESCANABA, MICH.



CARD.

In compiling this work a large number of illustrations have been introduced to more fully describe the various parts of the workings, but owing to the smallness of the page, most of these are too small to carry much value except to make a record of them.

There are a number of tables of the same character so small as to be read with difficulty. Full sized prints of the plans will be furnished at the regular price for such plans and the tables will be furnished at small advance of cost.

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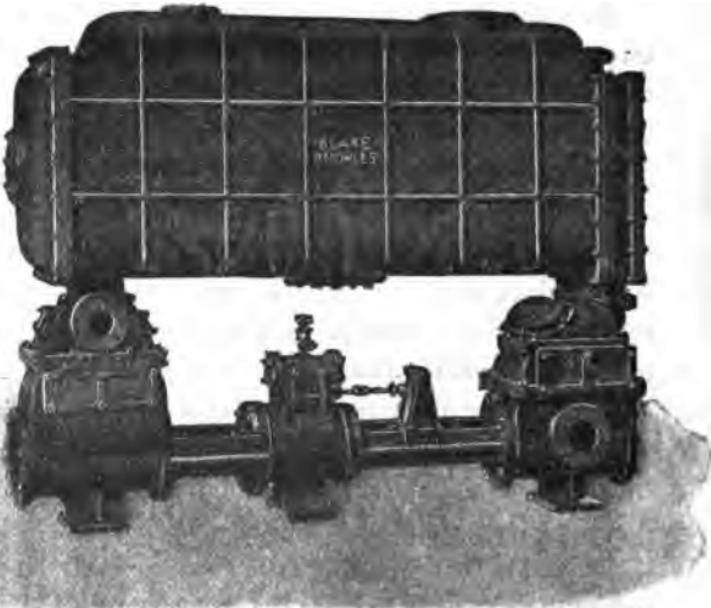
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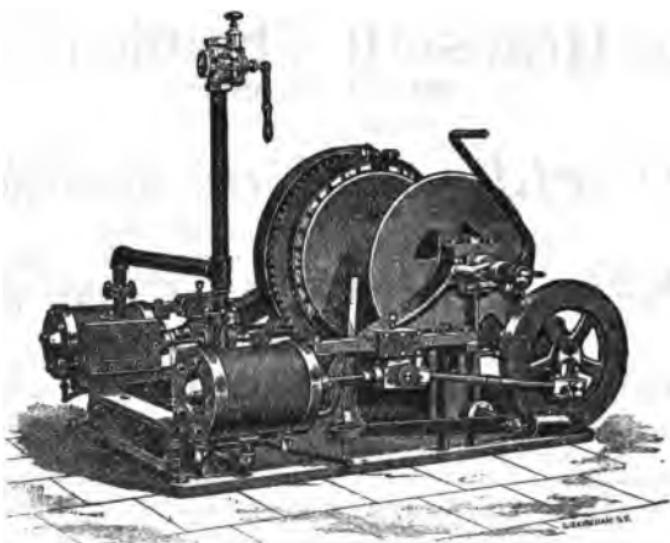
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- 1897. T. T. & L. P. Co. Somerville, Tex. Plans, Supervision and Operation.
- 1898. Santa Fe Pac. Bellemont, Ariz. Plans, Supervisions and Operation.
- 1898. C. & E. I. R. R. Mt. Vernon, Ill. Plans revised for O. Chanute.
- 1899. Great Northern Ry. Kalispell, Mont. Plans, Supervision and Installation.
- 1899. B. & M. R. Ry. Edgemont, S. Dak. Plans, Supervision and Installation.
- 1900. H. C. Sugar Co. Hawaii, S. I. Plans with full directions.
- 1900. Mex. Cent. R. R. Mexico. Consulting Engineer.
- 1901. M. K. & T. Ry. Greenville, Tex. Plans, Supervision and Installation.
- 1901. Alamogordo L. Co. Alamogordo, N. M. Plans, Supervision and Installation.
- 1901. Rocky Mt. Timb. Co. Colo. Plans, Supervision and Installation.
- 1902. Ayer Lord Tie Co. Carbondale, Ill. Consulting Engin'r.
- 1902. " " " Miss. Consulting Engineer.
- 1902. Union Pacific. Portable Plant. Shop Inspection.
- 1902. O. R. & N. Co. " "
- 1902. A. T. & S. F. Plans and Specifications.
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ROWE & ROWE

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General Chemical Co., 185 Adams St., Chicago.

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e Hohmann & Mauer Mfg. Co., 119 Lake St., Chicago.

A. Daigger, 182-184 E. Lake St., Chicago.

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We stinghouse Electric and Mfg. Co., Pittsburg, Pa.

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Diamond Glue Co., R. 422, 218 La Salle St., Chicago.

American Glue Co., 148-150 E. Kinzie St., Chicago.

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W. B. Rose Supply Co., Lincoln Trust Bldg., St. Louis.

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Chicago Bridge & Iron Co., 105th & Throop Sts., Chicago.

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Northern Extract Co., 144 Kinzie St., Chicago.
A. Klipstein & Co., 128 Pearl St., New York.

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Paige Iron Works, Room 427 Monadnock Bldg., Chicago.
Ajax Forge Co., 138 E. Jackson Blvd., Chicago.

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Chapman Valve Co., 28 S. Canal St., Chicago.
Eddy Valve Co., Waterford, N. Y.
Jenkins Bros. Valve Co., 31-33 N. Canal St., Chicago.

Differential Pulleys.

H. Channon Co., Market & Randolph Sta., Chicago.

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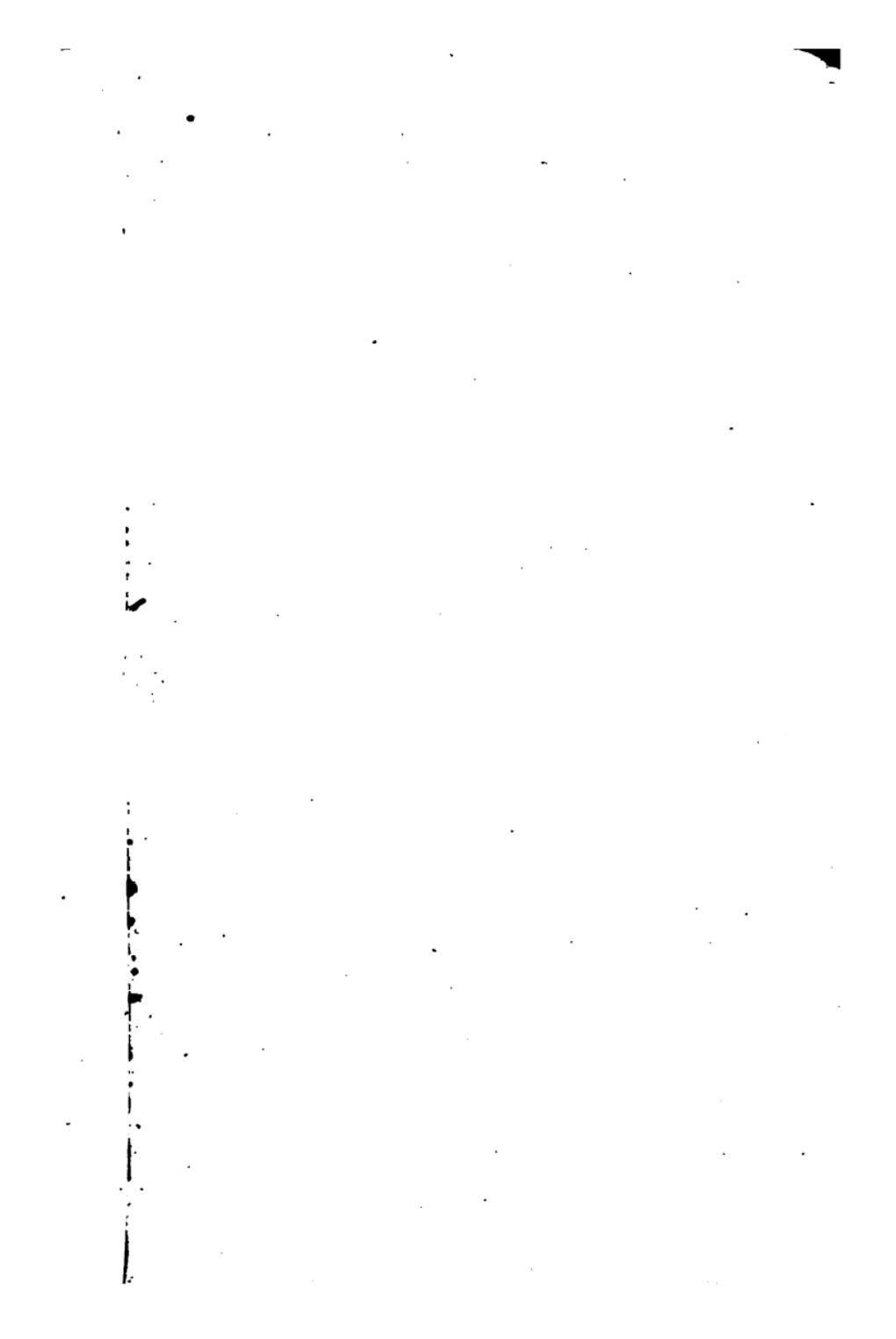
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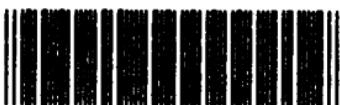
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